BULLETIN

OF THE

CHICAGO ACADEMY OF SCIENCES

THE RING-NECK SNAKES, GENUS *DIADOPHIS*

BY

FRANK NELSON BLANCHARD

Late Associate Professor of Zoology
University of Michigan

CHICAGO
Published by the Academy
1942

Vol. 7, No. 1 December 30, 1942

BULLETIN

OF THE

CHICAGO ACADEMY OF SCIENCES

THE RING-NECK SNAKES, GENUS *DIADOPHIS* *

BY

FRANK NELSON BLANCHARD

CONTENTS

Contribution from the Department of Zoology, University of Michigan.

FOREWORD

Investigations concerning the systematics, variation, evolution, and bionomics of the ring-neck snakes were among Dr. Frank N. Blanchard's chief interests in research for fifteen years. His first publication on the genus *Diadophis* (1923) contained comments upon the taxonomy of western species and descriptions of four previously unrecognized subspecies : *arizonae* from Arizona and *similis, vandenburghii,* and *occidentalis* from California. His "Key to the Snakes of the United States, Canada and Lower California" (1925) included twelve species and subspecies of *Diadophis* recognized at that time and gave definitions of their geographic ranges.

In the course of his summer work at the University of Michigan Biological Station during the early 1920's, he became especially interested in the habits and life history of *Diadophis punctatus edwardsii,* common in northern Michigan, and studied various aspects of its natural history with great thoroughness. These investigations continued until 1937 and resulted in three papers (1927, 1930, and 1937) dealing chiefly with the eggs, young, natural nests, and related topics, all executed with his characteristic skill and diligence.

Throughout this period of years, data were being accumulated toward a systematic revision of the genus and an analysis of speciation as revealed by the geographic distribution and structural variations in these snakes. The manuscript of this paper was essentially complete at the time of his death on September 21, 1937. Mrs. Blanchard requested me to prepare it for publication.

When the manuscript and accompanying data were turned over to me it was noted that there was no introductory section. In spite of some doubt of one ever having been prepared, we were reluctant to proceed without it, and delayed action for nearly two years in the hope that it would be discovered. Remarks which Dr. Blanchard made during our western trip of 1935-6 gave me the impression that he was then contemplating a modification of this part of the manuscript, an indication that at least a first draft had been prepared. Not finding it has been a keen disappointment, for I understood that he had included, or planned to include, in it a summary of his general conclusions on speciation in snakes. The body of the paper, however, is a valuable contribution to systematic herpetology and of such great usefulness as to justify publication even though an introductory section is not available.

Two important last-minute changes which Dr. Blanchard evidently planned to make should be mentioned here. Previous to his visit to the California Academy of Sciences in December, 1935, where he had an opportunity to examine the type series, he had considered *Diadophis anthonyi* (Van Denburgh and Slevin, 1923) from South Todos Santos Island as a synonym of *Diadophis amabilis similis*. After studying the specimens available on this occasion, he decided that *anthonyi* should be regarded as a valid subspecies of *Diadophis amabilis*. Accordingly he modified his key to include it and prepared a diagnosis. With the aid of data furnished by Joseph R. Slevin, I have completed the descriptive account of this subspecies.

The second change involved the midwestern subspecies, *Diadophis punctatus arnyi* (Kennicott, 1859). Early in the course of this study, Dr. Blanchard had given careful consideration to the status of *Diadophis docilis* (Baird and Girard, 1853). He had reached the conclusion that, in spite of certain striking differences, the type of *docilis* from western Texas was probably a peripheral representative of the population known for many years as *arnyi* and, if this were true, the name *docilis* by priority would supersede *arnyi* for the midwestern population. In the taxonomic treatment of this subspecies he proceeded according to this concept, but with obvious reluctance. Some time later he had an opportunity to examine a series of specimens (Strecker Museum, Baylor University) from Chrystoval, Texas, which together with another (ANSP 3469) labeled "Llano Estacado" exhibited the same differences from *arnyi* as the type of *docilis*. It became clear that here was another subspecies, hitherto unrecognized, to which the name *docilis* was definitely applicable. Again he modified the key but apparently had found no opportunity to revise the account of the subspecies (*arnyi* + *docilis*) which he had described under the name *docilis*. Since his intentions were clear from the corrected key, from penciled notations on the manuscript, and from his notes on the specimens concerned—I have had no hesitancy in making this separation.

With the exception of modifications made obligatory by the circumstances just described, only minor editorial changes have been made. Interpolations which seemed to me necessary or desirable have been placed in brackets. Much new material has accumulated in many collections since Dr. Blanchard's studies came to an end, and some recent publications pertinent to the present study have appeared. An attempt to bring up to date the published references to *Diadophis* was considered impracticable, but some of the more important papers have been cited in the text (also in brackets) and the page references to the fourth edition of the Stejneger and Barbour "Check List of North American Amphibians and Reptiles" have been added to the synonymies. It has not been possible to check all references listed in the synonymies but

a diligent effort has been made to follow the original manuscript exactly.

In view of recent criticism of the publication of detailed synonymies in revisions of more or less monographic scope, I should like to present here what I believe was Dr. Blanchard's point of view. If the author of a monograph is a careful worker, he examines published references as systematically as he studies the specimens which pass through his hands. In addition to listing the actual synonyms, thus expressing the author's conclusions on the validity of names which have previously been applied, the synonymy represents the author's findings on the status of the populations or specimens described or mentioned in earlier publications, and brings into orderly arrangement an abbreviated history of the species or subspecies as he understands it. Such a synonymy, therefore, is definitely something more than a list of papers from which the author obtained information, for it expresses the author's chain of reasoning.

Evidently Dr. Blanchard hoped to publish complete scale counts, measurements, and other individual notes on all specimens used in this study, but since the printing of such extensive tabular matter greatly increases the expense and difficulty of publication, it was decided simply to list the material examined. It is believed that the summaries of scutellation in Table II and in the descriptive section under each species and subspecies will suffice for general purposes. The listing of specimens by geographic localities and museum numbers shows exactly what material forms the basis of the study, and will facilitate the checking of uncertain points if other workers desire to examine material from critical areas.

The maps showing geographic distribution have been compiled by me from the lists of material examined by Dr. Blanchard. Since the specimens regarded as intergrades are in most cases discussed in the text, they have been indicated on the maps by the respective symbols of the subspecies under which they are listed. No previously published records have been mapped each recurrence of a given symbol on a map represents the locality of one or more specimens studied by the author himself. Where a species or subspecies is represented by specimens from numerous, more or less adjacent, localities (e.g., *D. a. similis* in southern California) , a single symbol obviously must represent more than one locality.

It has often been remarked, somewhat facetiously, that the so-called spot-map indicates not the distribution of the animals but the distribution of collectors, and that a shaded or hatched map is preferable since the reader is not interested in the exact localities from which the author's material came but in the conclusions for which they form a basis. The first of these statements is amusing and doubtless had some validity before the improvement of roads, the construction of highways, and the increase of automobiles made nearly all parts of the United

States easily accessible. The second, to my mind, seems to insist upon an ideal practically unattainable, as yet, in herpetological monographs. To be satisfied with an author's interpretations and conclusions without seeing his objective data, one needs assurance that there was an adequate amount of accurate factual material, that the author was completely capable of evaluating and interpreting it, and that it could point only to the conclusions reached by the author. Some graphic scheme combining the spot-map and the deduced geographical distribution of the population studied, such as that used by Hubbell in his recent monograph of the insect genus *Ceuthophilus (1936)* , would be highly desirable for reptiles, but would require a detailed and extensive knowledge of ecological factors which has not yet been attained on a continental scale. In the present study, for example, Dr. Blanchard was seriously, and consciously, handicapped by a lack of first-hand knowledge of the ecology of ring-neck snakes in California.

Figures illustrating the color patterns of twelve species and subspecies of *Diadophis* are from drawings by Elsie Herbold Froeschner. Capitalized color-names in the text refer to Ridgway's "Color Standards and Color Nomenclature."

It is manifestly impossible for another person to give acknowledgment by name to all of Dr. Blanchard's colleagues, friends and former students who provided material as gifts or loans, or otherwise aided him in his study; but they all know, I am sure, that he was sincerely appreciative. For courtesies extended to me while editing this manuscript I am indebted to Leo T. Murray, Joseph R. Slevin, L. M. Klauber, and William H. Stickel, and to Dr. Frieda Cobb Blanchard who has given all possible assistance.

It has given me sincere pleasure to have had a part in the completion and publication of this important contribution by my teacher and friend.

H. K. GLOYD.

Chicago,
June, 1942.

Genus DIADOPHIS Baird and Girard

1853. *Diadophis* Baird and Girard, Cat. N. Amer. Rept., pt. 1, p. 112 (Type *Coluber punctatus* Linnaeus, Syst. Nat., ed. 12, vol. 1, 1776, p. 376).

DESCRIPTION OF THE GENUS

Diagnosis. The genus *Diadophis* may be diagnosed as follows: maxillary teeth 9 to 21, solid, the anterior a little smaller, the remainder subequal except for the last two which may be enlarged and separated from the others by a short interspace; neck but little if any constricted; head small, eye of moderate size, pupil round; dorsal scales smooth, each with one apical pit, in 13 to 19 rows; anal plate divided; tail of moderate length; caudal scales in two rows; spermatic sulcus bifurcate.

Scutellation. The cephalic plates are normal, consisting of paired parietals, prefrontals, internasals, and supraoculars, and a single frontal; the nostril lies between two nasals; the loreal is present; there are two preoculars and two postoculars; the anterior temporal is single; the posterior temporal is normally single except in *dugesii,* which has two; the upper labials are normally 7 (except for *punctatus* and *edwardsii,* where they are 8 and *dugesii* where they are indifferently 7 or 8) ; the lower labials are normally 8, varying frequently to 7. The first lower labials meet on the median line behind the triangular mental plate and are followed by two pairs of chin shields of approximately equal length, the posterior of which are somewhat narrower.

On the body there are from 13 to 19 longitudinal rows of dorsal scales; the scales are wider on the lower rows and narrower above, all perfectly smooth, except in the anal region in males; each scale is provided with one inconspicuous pit near the posterior extremity (two pits have been noted at times and sometimes there appear to be none) . On the abdomen is a single series of large transverse plates, the ventrals, which vary in number in the genus from 126 to 239. These are terminated posteriorly by an obliquely divided anal plate (found undivided in a few specimens of *arnyi, amabilis, vandenburghi* and *occidentalis).* The preanal plate is somewhat infrequently divided. The plates under the tail, the caudals, are normally in two rows, but occasional individuals have one or several of these entire; they vary in number in the genus from 30 to 76.

Proportions. The head is somewhat truncate in front, flattened dorsoventrally and but slightly wider than the neck. The body is rounded above and relatively slender in all forms, tapering markedly only on the tail. The body is much more attenuated in the western races than in the eastern. The tail is short, tapering to a horny tip and varying from .107 to .261 of the total length. The sex of an individual, particularly of an adult, may be determined from the shape of the tail: in males the tail is conspicuously plump for some distance behind the anus while in females it tapers markedly in this region.

Coloration.—The coloration above is some tone of slate or brownish slate, darker in some forms and lighter in others, but lightest of all in *regalis* and *lætus.* The head above is a little darker than the body. On the neck [except in most individuals of *regalis]* is a narrow crossband of red or orange bordered narrowly with black. The lower surfaces are orange or yellow, changing posteriorly in some forms to deep red under the posterior part of the body and under the tail. In most forms the lower surfaces are irregularly spotted with black, but in two *(stictogenys* and *punctatus)* the spots are in a single median line and in two others *(edwardsii and pulchellus)* there are usually no black spots whatever.

Penial Characters.—The penial characters are as follows (in terms used by Cope, 1894, p. 831) : organ elongate, nearly cylindrical, terminating in two short, equal lobes; spermatic sulcus forked, each fork ending in a distal lobe; at the base of the organ, minute spines; at the tip and extending slightly below the lobes, calyces with low borders; remainder of organ covered with numerous spines of moderate size, arranged approximately in longitudinal rows; three spines a little larger than the others and situated proximal to the spiny tract are located as follows: one, the largest, posterolateral; one anteromedial; and one, distal to these two, posteromedial (sulcus curving posteriorly around and close to this spine). This description is based upon specimens of *arnyi* and, although no detailed study was made of variation in this organ, appears to fit several widely differing forms of the genus.

Dentition.—The dentition may be summarized as follows: maxillary teeth 9 to 21 (9 to 14 in western forms, 12 to 21 in eastern) , the last two larger than those preceding and separated from them by a distinct interspace, except in *punctatus* and *edwardsii* where the last two may be little if any larger and may be separated by little if any interspace; mandibular teeth 16 to 23; palatines 7 to 13; pterygoids 16 to 26. Only the

maxillary teeth have been counted in a sufficiently large series of specimens for the figures to be reliable.

HABITAT AND HABITS

The ring-neck snakes are secretive and apparently adapted to forested regions. This is indicated by the flattened head, small eyes, slender body of uniform dimensions, and lack of agressive habits as well as by the majority of recorded observations. All, presumably, lay eggs. Except for the forms *edwardsii* and *arnyi* very little of significance has been recorded on their habits; it is therefore to the accounts under these forms that the reader is referred.

RANGE

The genus *Diadophis* is represented throughout eastern North America north to about the 49th parallel and in the far west to southern Washington; southward it extends into central Mexico. It has not been found in southern Baja California.

VARIATION

Ventrals and Caudals.— The number of ventrals varies in the genus through a range of 113. The smallest forms *(stictogenys* and *punctatus)* may have as few as 126 and the largest *(regalis* and *laetus)* may have as many as 239. The subspecies of *punctatus* have commonly less than 170 ventrals and the subspecies of *amabilis* have about 200. The average range of variation in any subspecies is about 29.

The number of caudals varies in the genus through a range of 46. The smallest number (30) is found in *arnyi* and the largest (76) in *pulchellus.* The average variation for each subspecies is about 17.

Scale Rows. The variation in number of scale rows in *Diadophis* is not great. The highest formula observed was 17-19-17. This was found in two females of *dugesii,* and in one male of *arnyi* from Clifton, Texas. The lowest formula normal to any of the subspecies is 15-13 (common

in *similis, amabilis, occidentalis* and probably *pulchellus)*. The formula 13-13 was found in one specimen of *edwardsii.* The commonest formulas are 17-15 and 15-15.

Reduction in number of scale rows from 17 to 15 is accomplished by loss of the eighth row, and from 15 to 13 by loss of the seventh. In other words, reduction from 17 to 15 and from 15 to 13 is brought about by loss of the rows adjacent to the middorsal row.

Labials.—The upper labials are seven in most forms in the genus, but they are eight as a rule in *punctatus* and *edwardsii* and seven or eight in *dugesii.* Occasional individuals show reduction to six. The lower labials are characteristically eight in all forms but seven is a common modification, and very rarely nine are found.

The seven labials in the upper series very nearly match labials two to eight in the lower series. The eye lies above the third and fourth in the upper row.

Eight upper labials result, in all cases examined, from the interpolation of a narrow scute between the second and third; or, *we* may say, by the addition of a third. This may be expressed diagrammatically as follows:

$$\frac{7-8}{3}$$

in which the upper figures represent the total numbers of upper labials and the lower figure represents the number of the scute added, when the increase is from seven to eight. Reduction of the lower labials from eight to seven is apparently effected, in the large majority of individuals, by a fusion of the third and fourth. If it is fair to regard this as an involvement of the third scute, the symbols used above to express change in the upper labials then hold as well for the lower series.

Cases of change from seven to six are not common but the majority of these changes are effected by an apparent fusion of plates six and seven. If we regard this as a loss of the sixth, we then have the rule for *Diadophis* as follows:

$$\begin{matrix} 6-7 & 8 \\ 6 & 3 \end{matrix}$$

This is particularly interesting in view of the rule deduced by the writer for change in labial number in king snakes, *Lampropeltis* (1921, p. 14). This rule has been expressed diagrammatically as follows:

$$\begin{array}{cccccccc} 6 & - & 7 & - & 8 & - & 9 & - & 10 & - & 11 \\ & 6 & & 3 & & 7 & & 4 & & 8 & \end{array}$$

In the upper row are expressed the number of labials, either upper or lower, and in the lower row are given the scutes involved in the changes indicated by the numbers above. Thus, the rule for *Lampropeltis* holds also for *Diadophis,* within the limits of ordinary variation in the latter genus. Nine lower labials have been observed twice in *Diadophis.* In one case the seventh was divided to effect this and in the other case the third was divided.

The rule derived by Ruthven (1908, p. 29) for the garter snakes, *Thamnophis,* can be expressed in these symbols as

$$\begin{array}{ccccccc} 6 & - & 7 & - & 8 & - & 9 \\ & 6 & & 3 & & 4 & \end{array}$$

Possibly further study would show the garter snakes to conform in general with the rule for *Lampropeltis,* for in Ruthven's own words *(op. cit.,* p. 31) "the loss of the scutes in both series takes place first in front and then behind the eye," and this is not borne out by the symbolic expression above.

Color Pattern. All forms of *Diadophis* agree in possessing a transverse band of red or orange behind the head, except for *regalis,* where it is characteristically absent. In some forms this band, or ring, is more or less commonly interrupted in the median line by an encroachment of the general body color. The rest of the body above is unicolor, and generally dark, the head a little darker than the rest. The underside is orange, changing posteriorly in most forms, to red under the tail, and usually marked with black spots. The latter are scattered in most forms, but in two *(stictogenys* and *punctatus)* they are arranged in a median line, and in two others *(edwardsii* and *pulchellus)* they are normally absent.

Maxillary Teeth. The number of maxillary teeth seems to be characteristic of the subspecies or group of subspecies. Thus, there is little

variation among the forms of *amabilis,* but in the *punctatus* group three are found closely similar to each other and different from the fourth (Table I) .

The last two teeth of the maxillary series are characteristically enlarged and separated from the rest, but in *stictogenys, punctatus* and *edwardsii* they tend to be smaller and less separated. In fact in many specimens of *edwardsii* the last two teeth are not differentiated from the preceding either in size or position.

Table I. Variation in Number of Maxillary Teeth in the Forms of *Diadophis.*

Species and Subspecies	Number of Jaws Counted	Extremes	Averages
amabilis			
modestus	20	10-12	11.1
vandenburghi	14	11-13	11.8
occidentalis	10	11-12	11.5
pulchellus	6	12-14	13.0
amabilis	8	11-12	11.8
similis	8	11-12	11.5
dugesii	6	11-12	
regalis			
laetus	6	9-11	10.3
regalis	*0*		
punctatus			
arnyi	16	12-15	13.6
stictogenys	7	15-21	16.9
punctatus	12	15-20	16.7
edwardsii	29	15-19	17.3

Differences between the Sexes. —The sexes differ chiefly in relative length and width of body and tail. The body is longer and wider and the tail is shorter and more slender in females than in males. These differences may be expressed in several ways. The number of ventrals in females averages from 7 to 16 more than in males in the forms of *amabilis,* and from 9 to 13 more in the subspecies of *punctatus;* and the caudals average from 6 to 8 more in males than in females. Since the sex that has the longer body has the shorter tail, and vice versa, the difference between the sexes is increased by subtracting the number of caudals from the number of ventrals. The figures thus obtained for one sex

overlap but little the like figures for the other sex in any subspecies. For local populations it is possible that there is no overlapping in this respect, for this proved to be true in the large series of specimens examined from Oklahoma (489 in number) .

The relative length of the tail averages 2.5 to 4 per cent greater in males than in females. The figures of relative tail length (obtained by dividing the tail length by the total length and carrying the results to the nearest third decimal place) for all specimens of a subspecies overlap relatively little between the two sexes. In fact, nine times out of ten, the sex may he determined correctly from this figure alone, according to the results of measuring several hundred specimens of *arnyi* and *edwardsii*

Another rather constant difference between the sexes is the possession by the males of keel-like ridges on the dorsal scales in the vicinity of the anus. These anal ridges, as they have been called, are characteristic of sexually mature males (Blanchard, 1931, p. 99) although they are possessed to a limited extent by some immature males and a few females, and a few adult males do not have them.

As is characteristic of snakes in general, the tail in males is plump for a little distance behind the anus and of about the same width as the posterior end of the body; after this it tapers gradually to the end. In females, on the contrary, the posterior end of the body is wider than the anterior end of the tail, and the latter tapers more abruptly and from farther forward than that of the male. The difference in length may be noticeable without measuring. The wider tail of the male is of course correlated with the presence of the hemipenes and the wider body of the female is presumably related to the bearing of eggs.

As to whether females of *Diadophis* are larger than males there seems to be some doubt. It has appeared from a study of *edwardsii* (Blanchard, *op. cit.,* p. 98-99) that males become sexually mature at a slightly smaller size than females but there was no significant difference in the average lengths of adults of the two sexes. However, in the large series of *arnyi* examined there are more large females than large males (Fig. 17) and the same appears now to he true of *edwardsii* (Fig. 24) . Furthermore, in every form of *Diadophis* except two (which are represented by but few examples) the largest specimen examined was a female. Perhaps it may be tentatively concluded that, although as a rule females are little, if any, larger than males, the females are a little longer when they attain maturity and individuals tend to reach a greater length than males.

SUBDIVISIONS OF THE GENUS

The forms of *Diadophis* now known fall readily into four natural groups: the eastern, or *punctatus* group, including five subspecies; the southwestern, or *regalis* group, of two subspecies; the Californian, or *amabilis* group, of seven subspecies; and the single Mexican species *dugesii.*

These groups may be characterized in a general way as follows: *dugesii* is a rather large species with scale rows 17-17 or 17-19-17 and two temporals in the second row. The ventrals and caudals are moderate in number, and the dark color of the upper surfaces extends down over the first row of scales. Both forms of the *regalis* group are very large and long for the genus and possess a very high number of ventrals. The scale rows are 17-15 and the general coloration is very pale. The forms of the *amabilis* group are unusually long and slender. The ventrals are approximately 200 and the scale rows vary with the subspecies from 17-15 to 15-13. In both the *amabilis* and *regalis* groups the ventral color extends to some extent onto the dorsal scales. The members of the *punctatus* group are not as slender-bodied as the others; the ventrals are fewer, well below 200, and the belly color does not extend onto the dorsal scales. The latter vary from 17-17 to 15-15.

KEY TO THE SPECIES AND SUBSPECIES OF *DIADOPHIS*

Due to the wide range of individual variation within the subspecies it is impossible to make a key that will correctly identify every specimen. The summary of structural characters (Table II) should be a useful adjunct to the key. Persisting uncertainties should be referred to the full descriptions.

1. Ventral color usually extending, on anterior portion of the body, onto one or more of lowermost rows of dorsal scales. 2

   Ventral color not extending onto lowermost row of dorsal scales (except rarely at extreme anterior end) . 10

2. Difference between number of ventrals and number of caudals 139 or more in males and 160 or more in females. 3

   Difference between number of ventrals and number of caudals 141 or less in males and less than 160 in females. 4

3. Neck ring present, 2 to 4 scales in width. ***D. regalis laetus.***

   Neck ring absent or much reduced. ***D. regalis regalis.***

4. Scale rows 17-15 (rarely 15-15) . 5

   Scale rows 15-15 or 15-13 (rarely 17-15 or 15-17-15) . 6

5. Ventral color not extending over more than the first row of dorsal scales; belly usually conspicuously spotted with black. ***D. amabilis modestus.***

   Ventral color extending over 1 1/2 to 2 rows of dorsal scales; black spots on belly few and small. ***D. amabilis vandenburghi***.

6. Ventral color usually extending up over more than two-thirds of each scale in the first row of dorsal scales. 8

   Ventral color extending up onto one-third to two-thirds of each scale in the first row of dorsal scales. 7

7. Scale rows 13 in number near posterior end of body in all males and four-fifths of the females; typically a slender-bodied form; neck ring usually well defined. ***D. amabilis similis.***

Scale rows 15 in number near posterior end of body in both sexes; larger and stouter-bodied than the last; neck ring narrow and poorly defined; heavily spotted below. ***D. amabilis anthonyi.***

8. Neck ring from 1 to 1½ scale lengths in width, sometimes interrupted; ventral color covering from ½ to 1½ rows of dorsal scales; belly well sprinkled with small black spots; dorsal color usually dark. ***D. amabilis amabilis.***

Neck ring from 1½ to 3 scales in width, not interrupted; ventral color covering from 1½ to 2 or more rows of dorsal scales; belly rarely heavily spotted with black. 9

9. First two rows of dorsal scales flecked with black; belly rather conspicuously, although sparsely, marked with small, black dots. ***D. amabilis occidentalis.***

First two rows of dorsal scales not flecked with black; belly almost or quite unspotted. ***D. amabilis pulchellus.***

10. Ventral plates usually 170 or more in males and 180 or more in females. 11

Ventral plates usually less than 170 in males and 180 in females. 12

11. Dorsal scale rows usually 15-15 (less often 17-15) ; generally only a single posterior (i.e., second) temporal. ***D. punctatus docilis.***

Dorsal scale rows usually 17-17 (occasionally 17-15) ; generally two posterior temporals. ***D. dugesii.***

12. Chin with black spots; belly with black spots that are scattered or in a continuous median line. 13

Chin generally without black spots; belly typically unspotted, but sometimes with a more or less incomplete median line of small black spots (rarely with ill-defined, scattered spots) . ***D. punctatus edwardsii.***

13. **Spots on belly usually scattered, but sometimes in a median line or absent; difference between number of ventrals and number of caudals usually more than 99 in males and more than 115 in females; dorsal scales often in 17 rows.**
D. punctatus arnyi.

Spots on belly not irregularly scattered but arranged in more or less of a median line, or more or less confluent transversely on the ventrals; difference between number of ventrals and number of caudals usually less than 99 in males and less than 115 in females; dorsal scales in not more than 15 rows. **14**

14. **A single median line of clearly-defined, half-circular, black spots on belly; upper labials usually 8, but occasionally 7.**
D. punctatus punctatus.

Belly spots small and usually not perfecrly regular in shape, often tending to form a median line, or more or less confluent transversely; upper labials 7, rarely 8. *D. punctatus stictogenys.*

Table II. Summary of Structural Characters of the Species and Subspecies of *Diadophis*.

	Number of Specimens	Ventrals	Caudals	Ventrals minus Caudals	Upper Labials	Lower Labials	Scale Rows	Length of Tail Divided by Total Length	Length of Largest Specimen, mm.
modestus	36	♂ 181-195 (188) ♀ 188-215 (202)	61-71 (65) 55-64 (60)	117-131 129-152	7 (8)	8	17-15	♂ .192-.229 (.209) ♀ .151-.202 (.177)	533 ♀
vandenburghi	20	♂ 180-201 (190) ♀ 195-209 (200)	61-73 (67) 58-66 (62)	115-131 134-146	7 (8)	8	17-15	♂ .198-.217 (.209) ♀ .161-.197 (.183)	486 ♀
occidentalis	28	♂ 182-201 (188) ♀ 197-210 (204)	63-67 (65) 55-59 (57)	116-135 141-151	7 (8)	8 (7)	15-15 (15-13)	♂ .201-.221 (.209) ♀ .165-.190 (.174)	594 ♀
pulchellus	11	♂ 181-194 (184) ♀ 196-205 (203)	64-76 (69) 59-62 (61)	111-130 134-145	7	7-8	15-15 (15-13)	♂ .202-.229 (.215) ♀ .185-.196 (.190)	475 ♂
amabilis	62	♂ 183-201 (191) ♀ 196-211 (204)	59-70 (63) 51-63 (56)	120-141 135-158	7 (8)	8 (7)	15-15 (15-13)	♂ .176-.218 (.200) ♀ .151-.193 (.170)	474 ♀
similis	225	♂ 183-207 (194) ♀ 191-209 (201)	54-68 (61) 48-60 (53)	124-141 138-159	7 8)	8 (7)	15-13 (15-15)	♂ .172-.207 (.192) ♀ .122-.188 (.168)	524 ♀
anthonyi	3	♂ 182, 183 ♀ 192	63 34+	119, 120 - - -	7	8	15-15	♂ .203, .212 ♀ - - - - -	470+ ♀
dugesii	15	♂ 164-183 (176) ♀ 201-206 (202)	52-59 (57) 49-53 (51)	112-123 149-153	7 (8)	8	17-17	♂ 189-.213 (.202) ♀ .151-.161 (.158)	677 ♀
laetus	18	♂ 210-225 (216) ♀ 227-239 (233)	62-72 (69) 62-67 (64)	139-155 164-172	7	8	17-15	♂ .166-.212 (.187) ♀ .156-.177 (.165)	749 ♀
regalis	21	♂ 204-224 (216) ♀ 224-236 (230)	57-79 (65) 53-66 (60)	141-154 163-176	7	8	17-15	♂ .180-.204 (.190) ♀ .107-.167 (.154)	681 ♀
docilis	11	♂ 175-193 (186) ♀ 191-208 (200)	52-58 (55) 41-50 (47)	121-136 141-163	7	8	15-15 (17-15)	♂ .179-.189 (.185) ♀ .135-.157 (.148)	422 ♀
arnyi	823	♂ 142-169 (156) ♀ 151-185 (168)	37-57 (46) 30-50 (41)	90-122 109-149	7 (8)	8 (7)	17-15	♂ .153-.220 (.188) ♀ .125-.196 (.155)	361 ♀
stictogenys	73	♂ 126-143 (133) ♀ 137-150 (142)	38-51 (46) 33-43 (39)	80- 99 97-112	7	8 (7)	15-15	♂ .178-.241 (.207) ♀ .148-.201 (.169)	364 ♀
punctatus	115	♂ 127-150 (137) ♀ 134-155 (144)	43-56 (47) 34-50 (41)	79- 99 92-116	8 (7)	8 (7)	15-15	♂ .193-.242 (.215) ♀ .143-.210 (.180)	367 ♂
edwardsii	910	♂ 139-162 (151) ♀ 146-176 (160)	48-65 (57) 41-61 (51)	84-106 96-125	8 (7)	8 (7)	15-15	♂ .188-.261 (.231) ♀ .152-.226 (.200)	517 ♀

ABBREVIATIONS USED WITH REFERENCE TO MUSEUM SPECIMENS

ALA—Alabama Museum of Natural History, University, Ala.
ALLEN-M. J. Allen, Indianapolis, Ind.
AMNH—American Museum of Natural History, New York, N. Y.
ANSP—Academy of Natural Sciences, Philadelphia, Pa.
AU—University of Arizona, Tucson.
BAYLOR—Baylor University Museum, W aco, Texas.
BOGERT-C. M. Bogert, American Museum of Natural History, New York.
BOYER-HEINZE—Dorothy A. Boyer and Albert Heinze, University City, Mo.
BRIMLEY-C. S. Brimley, North Carolina Department of Agriculture, Raleigh.
BROOKLYN—Brooklyn Museum, Brooklyn, N. Y.
BYU—Brigham Young University, Provo, Utah.
CA—Chicago Academy of Sciences, Chicago, Ill.
CAHN—Alvin R. Cahn, University of Illinois, Urbana.
CAS—California Academy of Sciences, San Francisco.
CBS—Caribbean Biological Supply Co., Biloxi, Miss.
CGS—Geological Survey, Canada Department of Mines, Ottawa.
CLEMSON—Clemson College, South Carolina.
CORNELL—Cornell University, Ithaca, N. Y.
COWLES-R. B. Cowles, University of California at Los Angeles.
CSTC- Colorado State Teachers College, Greeley.
EVANS* -P. D. Evans, Kansas City, Mo.
FMNH—Field Museum of Natural History, Chicago, Ill.
FNB[t] —Frank N. Blanchard.
FSM—Florida State Museum, Gainesville.
HEID—Zoologisches Institute der Universität, Heidelberg, Germany.
KSC—Kansas State College, Manhattan.
KU—University of Kansas, Lawrence.
LAM—Los Angeles Museum, Los Angeles, Calif.
LMK—L. M. Klauber, San Diego, Calif.

*Collection now at Chicago Academy of Sciences.
[t] Specimens of *Diadophis* now at Chicago Academy of Sciences.

MCZ—Museum of Comparative Zoology, Cambridge, Mass.
MPM—Milwaukee Public Museum, Milwaukee, Wisc.
MVZ—Museum of Vertebrate Zoology, University of California, Berkeley.
MZUM—Museum of Zoology, University of Michigan, Ann Arbor.
NYM—New York State Museum, Albany.
OKMULGEE—Okmulgee High School, Okmulgee, Okla.
OREGON—Oregon State Agricultural College, Corvallis
OSM—Ohio State Museum, Columbus.
OTTAWA—Ottawa University Museum, Ottawa, Kans.
PACK—The late H. J. Pack, Farmington, Utah.
REED—Reed College, Portland, Ore.
S. DAK.—University of South Dakota, Vermillion.
SDS—San Diego Society of Natural History, San Diego, Calif.
S.D. ZOO—Zoological Society of San Diego, Calif.
STANFORD-Museum of Natural History, Stanford University, Calif.
T-S—Collection of E. H. Taylor and H. M. Smith, University of Kansas, Lawrence.
TULSA—Tulsa High School, Tulsa, Okla.
TZS—Toledo Zoological Society, Toledo, Ohio.
ULMZ—University of Louisville, Museum of Zoology, Louisville, Ky.
UOMZ—University of Oklahoma, Museum of Zoology, Norman.
USNM—United States National Museum, Washington, D. C.
UTAH—University of Utah, Salt Lake City.
VIOSCA—Percy Viosca, Jr., New Orleans, La.
WASH.—State College of Washington, Pullman.
WISC. U.—University of Wisconsin, Madison.

Diadophis amabilis modestus (Dumeril and Bocourt)

Los Angeles Ring-neck Snake

Fig. 1

1863. *Diadophis punctatus amabilis* JAN, Prod. Icon. Gen. Ofid., p. 52, 55; Elenco Sist. degli Ofid., 1863, p. 49; Arch. Zool. Anat., 1863, p. 262, 265; Icon. Gen. Ophid., liv. 15, 1866, pl. 6, *fig. 4.*

1866. *Diadophis punctatus modestus* DUMERIL AND BOCOURT, Miss. Sci. Mex., pt. 3, p. 623 (Type locality, California; cotypes in Paris Museum; M. de Cessac, collector).

1894. *Coronella amabilis* (part) BOULENGER, Cat. Snakes Brit. Mus., vol. 2, p. 207 (San Bernardino).-Diadophis *amabilis* VAN DENBURGH, Occ. Papers Calif. Acad. Sci., no. 5, 1897, p. 166 (Ontario, San Bernardino County).-GRINNELL, Univ. Calif. Publ. Zool., vol. 5, no. 1, 1908, p. 164.-RUTHLING, Copeia, no. 15, 1915, p. 4.-GRINNELL AND CAMP, Univ. Calif. Publ. Zool., vol. 17, no. 10, 1917, p. 186, fig. 12 (part).

1922. *Diadophis amabilis modestus* VAN DENBURGH, Occ. Papers Calif. Acad. Sci., no. 10, vol. 2, p. 650.-BLANCHARD, Occ. Papers Mus. Zool. Univ. Mich., no. 142, 1923, p. 8; Papers Mich. Acad. Sci. Arts, Let., vol. 4 (1924), 1925, pt. 2, p. 35.-BOGERT, Bull. S. Calif. Acad. Sci., vol. 29, pt. 1, 1930, p. 9.-STEJNEGER AND BARBOUR, Check List, ed. 3, 1933, p. 89; ed. 4, 1939, p. 97.

DESCRIPTION

Diagnosis.-Features characteristic of this form are a moderately narrow neck ring, one-half to two scales in width; 17 rows of scales at the anterior end of the body, the ventral color extending only a little onto

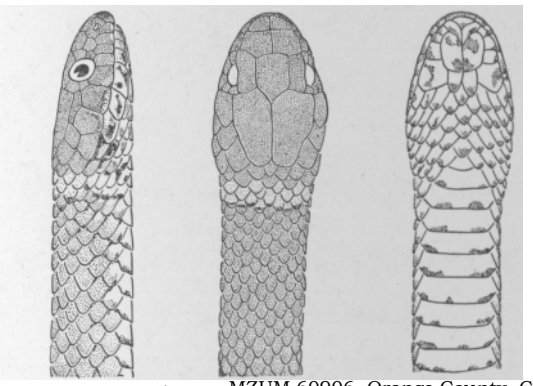


Fig. 1. *D. a. modestus,* MZUM 60906, Orange County, Calif.

the first row of dorsal scales; the belly usually heavily spotted with black (in particular the ends of the ventrals generally each bearing a black dash); and bodily proportions distinctly stouter than *amabilis*.

Scutellation. Thirty-six specimens form the basis of the following summarized scutellation: ventrals 181 to 215 (males 181-195, av. 188; females 188-215, av. 202) ; caudals 55 to 71 (males 61-71, av. 65; females 55-64, av. 60) ; upper labials 7, less often 8; lower labials 8; preoculars 2; postoculars 2 (in one instance 3) ; temporals 1+1, rarely 1+2; posterior chin shields in contact, a little narrower and generally a little shorter than the anterior pair; scale rows 17-15 (in one specimen 15-15, in another 15-17-15) . Of the males examined all over 300 mm. in length have anal ridges on the dorsal scales near the vent; none of the females have them.

Form and Size. The body, as compared with the other subspecies of *amabilis,* is rather thick in proportion to its length. The tail varies from .151 to .229 of the total length (males .192-.229, av. .209; females .151-.202, av. .177) . The largest specimen examined measured 533 mm. and was a female from Arroyo Seco, Los Angeles County, California.

Coloration. — The coloration, judged from preserved specimens, is bluish-slate to nearly black above, darker on top of the head. The lower surfaces are yellowish, usually heavily spotted with black. The ventral color generally extends onto the first row of scales never covering it; but in occasional individuals the dorsal color reaches quite to the ventrals. The ventral spots are generally rounded anteriorly along the middle of the belly and sometimes also along the ends of the ventral plates, but the latter are more characteristically marked with conspicuous transverse dashes. The neck ring varies from one-half to two scales in width, and is bordered behind with a few black dots. Labials and chin are prominently spotted with black.

In life the neck ring and lower surfaces are doubtless largely Coral Red, redder toward the tail and more orange anteriorly.

Dentition. — The maxillary teeth in eight specimens examined numbered from 10 to 12. Five maxillae gave counts of 10; nine gave counts of 11; and two gave 12. The last two teeth are distinctly larger than the others, and are separated from them by a moderate interspace.

HABITAT AND HABITS

According to Grinnell and Grinnell (1907,p. 39), " This elegant little snake appears to be fairly common in the canyons and hilly country of many parts of the county [Los Angeles] . We have found it in August feeding on young tree toads within a few feet of the stream in the Arroyo Seco Canyon. We have also found it in early spring coiled up in cavities under rocks."

It has been taken several times in the San Bernardino Mountains at altitudes of 4000, 5500, and 6400 feet. Grinnell (1908, p. 164) says of the specimen taken at 6400 feet, on the upper Santa Ana, near the mouth of Lost Creek: "This individual showed a trait of behavior new to me. When thoroughly alarmed and its escape into the brush for which it headed was prevented, the snake twisted its tail into a tight corkscrew, the vermilion urostegal surface outermost. This caudal contrivance shone out with conspicuous brilliancy, and *might* have some protective significance as a 'warning mark' ."

Bogert (1930, p. 9) reports it as moderately common throughout Los Angeles County, except on the desert and desert slope. During the months from February to May, 1929, he secured fifteen specimens in his yard in Los Angeles by overturning rocks. He reports a large individual, twenty-one inches long, as devouring a thirteen-inch specimen of the same species. "However," he says, "their food in this section appears to consist largely of *Batrachoseps attenuatus attenuatus."* One of his specimens ate a lizard, *Xantusia vigilis,* in captivity, killing it beforehand by constriction. The salamanders *(Batrachoseps),* however, were eaten without such preliminaries.

[J. C. von Bloeker (1942, p. 35) states that in the sand dunes of El Segundo, Los Angeles County, this snake is "frequently found under boards and rocks, and occasionally found buried in loose sand, similiarly to *Anniella pulchra";* and that one 17 inches long was found April 2, 1939, in the dune complex on top of the largest dune near a patch of tuna cactus.]

A specimen from Orange County was kept alive by the writer for some time. On one occasion it ate an adult cricket frog *(Acris gryllus)* and a week later it ate an adult swamp tree frog *(Pseudacris feriarum)* . As soon as the swamp tree frog jumped in front of the snake, the latter took notice and soon caught the frog head first. The frog was not constricted but swallowed directly. Thirty-four minutes were required to engulf it.

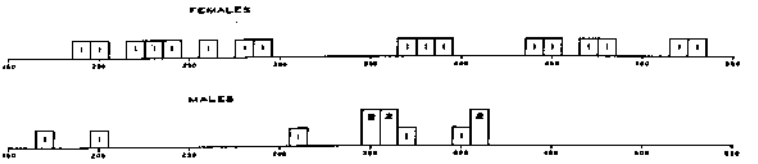


Fig. 2. Distribution by size (total length to nearest 10 mm.) and sex of 28 specimens of *D. a. modestus.*

Sexual maturity in males seems to be attained at about the same body length as in males of *similis,* but the series of specimens is too small to

bring this out with any exactness. Anal ridges occur on all specimens of this sex over 300 mm. in length (Fig. 2).

DISTRIBUTION

Range. Specimens have been obtained only from Los Angeles County, the western portion of the San Bernardino Mountains, Orange County, and San Diego County, California (Map 1).

MATERIAL EXAMINED

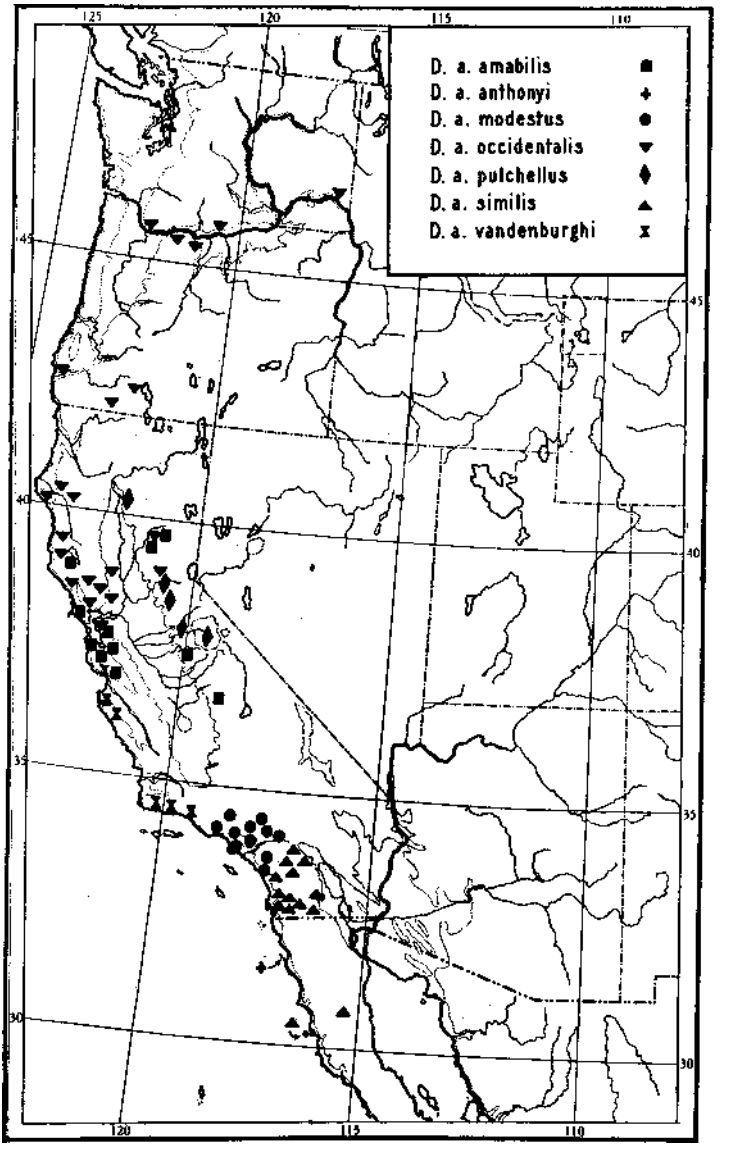
CALIFORNIA: *Los Angeles* Co.-USNM 56188-90, LMK 1741-2, 4604, LAM 328; Los Angeles, LMK 2817-8, BOGERT (5), Westwood Campus, U. C. L. A., COWLES 77; Azusa, AMNH 9374-5; Covina, AMNH 9428; Miller's Canyon, San Gabriel Mts., BOGERT 107; Arroyo Seco, BOGERT (1), FNB (3), COWLES 74-5, 438; Sierra Madre, CAS 27775; Claremont, CORNELL (2), MCZ 9063; Topanga Canyon, LAM 623; Pasadena, MVZ 680; Glendora, MVZ 6741; Placerita Canyon, USNM 69840-1; San Dimas Canyon, USNM 69842; Monrovia, LMK 3018, 4276; Millard Canyon, COWLES 76; Hollywood, COWLES 160. *Orange* Co.—Trabuco Canyon, MZUM 60906. *San Bernardino Co.*—San Bernardino Mts., Mill Creek, MVZ 681, Santa Ana River, MVZ 703; Ontario, STANFORD 4194. *San Diego* Co.—San Onofre, LMK 11855.

VARIATION AND AFFINITIES

The scutellation of this form shows in general the same limits of variation as the other subspecies of *amabilis.* (See Table II, page 20, and the general discussion of relationships in the *amabilis* group.)

The 17 rows of scales around the forward part of the body are not invariable. One specimen has only 15 rows throughout, another has the unusual arrangement of 15-17-15, and a third has 17 rows for only a very short distance behind the head. It is in the formula 17-15 that *modestus* shows conspicuous affinity with *laetus, regalis,* and *dugesii.* Another strong evidence of relationship with these forms is the fact that the dorsal dark color reaches nearly or quite across the lowermost row of dorsal scales, a feature shared also by *similis* to a somewhat lesser extent, but in this form the scale rows have been reduced to 15-13. All the other forms of *amabilis* are too specialized to be regarded as closely allied to the members of the *regalis* group.

We may best regard *modestus* as a derivative of *laetus* and ancestral to all other forms of *amabilis.*


D. a. amabilis
D. a. anthonyi
D. a. modestus
D. a. occidentalis
D. a. pulchellus
D. a. similis
D. a. vandenburghi
125
120
115
110
45
40
35
30

Diadophis amabilis vandenburghi Blanchard

Van Denburgh's Ring-neck Snake

1922. *Diadophis amabilis* VAN DENBURGH, Occ. Papers Calif. Acad. Sci., no. 10, vol. 2, p. 650, pl. 61.

1923. *Diadophis amabilis vandenburghii* BLANCHARD, Occ. Papers Mus. Zool. Univ. Mich., no. 142, p. 5, 8 (Type locality Carmel, Monterey County, California; type specimen CAS 13748, collected by Joseph R. Slevin, June 20, 1907) ; Papers Mich. Acad. Sci., Arts, Let., vol. 4 (1924), 1925, pt. 2, p. *35.—Diadophis amabilis vandenburghi* STEJNEGER AND BARBOUR, Check List, ed. 2, 1923, p. 82; ed. 3, 1933, p. 89; ed. 4, 1939, p. 98.

DESCRIPTION

Diagnosis.—This form is characterized by a moderately wide neck ring, not interrupted; by 17 rows of scales anteriorly and 15 posteriorly; by the ventral color extending onto from one and one-half to two rows of dorsal scales; by the black spots on the belly being few and small; and by somewhat stouter proportions than *amabilis.*

Scutellation.—The 20 specimens examined present the following scutellation: ventrals 180 to 209 (males 180-201, av. 190; females 195-209, av. 200) ; caudals 58 to 73 (males 61-73, av. 67; females 58-66, av. 62) ; upper labials 7 or 8; lower labials 8 (rarely 7) ; preoculars 2; postoculars 2; temporals 1+1; posterior chin shields in contact, a little shorter than the anterior pair; scale rows 17-15, occasionally 17 rows only at the extreme anterior end.

Form and Size. The proportions of the body are about the same as in *modestus* and *occidentalis.* The tail varies from .161 to .217 of the total length (males .198-.217, av. .209; females .161-.197, av. .183) .

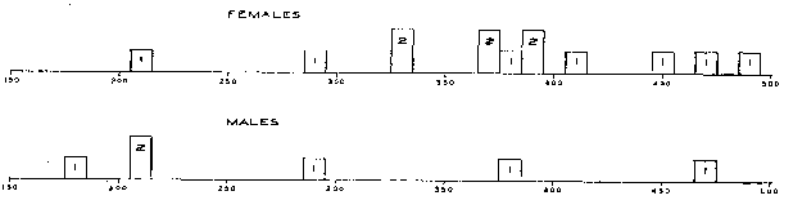


Fig. 3. Distribution by size (total length to nearest 10 mm.) and sex of 19 specimens of *D. a. vandenburghi.*

The largest specimen examined was a female 486 mm. in total length, collected near Santa Cruz, California. For lengths of all specimens see Fig. 3.

Coloration. The coloration, in preserved specimens, is gray or olive above and light below with usually only a few black spots. The ventral color extends over one and one-half to two of the lowermost rows of dorsal scales. Each scale of the lowest row has a black dot at its tip. The neck ring is usually about one and one-half to two scale lengths in width (extremes 1 to 2½), and is interrupted in two of the specimens examined (one from Gaviota and one from Santa Cruz) .

Dentition.—The maxillary teeth showed a variation, in fourteen counts, of 11 to 13 with an average of 11.8. The last two are enlarged and separated from the others by an interspace.

HABITAT AND HABITS

There appears to be no published reference on this subject relating to this particular form.

DISTRIBUTION

Range. The few localities from which specimens have been obtained indicate a range in the mountainous region from Ventura County north to Santa Cruz County, California (Map 1, p. 27) .

MATERIAL EXAMINED

CALIFORNIA: *Monterey* Co.—Carmel, CAS 13743-52, 27306-7, 39195, 41703, MVZ 18022; Pine Valley, head of Carmel River, USNM 44353; Santa Lucia Nat. Monument MVZ 16718. *Santa Barbara* Co.—Gaviota Creek, FMNH 2904; Santa Barbara, MVZ 8205. *Santa* Cruz Co.—Santa Cruz, MVZ 11238; Soquel Creek, CAS 17928. *Ventura Co.—Weldon* s, LAM 47.

VARIATION AND AFFINITIES

This form is closely related to *modestus* on the south and to *occidentalis* on the north. It apparently intergrades with *amabilis,* but its exact relation to this form is uncertain. Further discussion of its relationships may be found under the general discussion of the *amabilis* group.

Diadophis amabilis occidentalis Blanchard

Northwestern Ring-neck Snake

Fig. 4

1860. *Diadophis pulchellus* COOPER, Pac. R. R. Surv., vol. 12, bk. 2, pt. 3, no. 4, p. 302.

1863. *Diadophis punctatus pulchellus* JAN, Prod. Icon. Gen. Ofid., p. 52, 54; Elenco Sist. degli Ofid., 1863, p. 49; Arch. Zool. Anat., 1863, p. 262, 264; Icon. Gen. Ophid., liv. 15, 1866, pl. 6, fig. 3.-COPE, Proc. Acad. Nat. Sci. Philadelphia, 1883, p. 23, 27 (part).

1923. *Diadophis amabilis occidentalis* BLANCHARD, Occ. Papers Mus. Zool. Univ. Mich., no. 142, p. 6, 8 (Type locality Bridgeville, Humboldt County, California; type specimen MVZ 7260, collected by H. E. Wilder, May 30, 1919). -STEJNEGER AND BARBOUR, Check List, ed. 2, 1923, p. 82.-BLANCHARD, Papers Mich. Acad. Sci., Arts, Let., vol. 4 (1924), 1925, pt. 2, p. 36.-STEJNEGER AND BARBOUR, Check List, ed. 3, 1933, p. 89.-SVIHLA AND SVIHLA, Copeia, 1933, no. 3, p. 127.-STEJNEGER AND BARBOUR, Check List, ed. 4, 1939, p. 98.

DESCRIPTION

Diagnosis.—This is a large species with a relatively broad, uninterrupted neck ring, one and one-half to two scales in width, the ventral color extending over one and one-half to two of the dorsal scale rows, the belly lightly spotted with black, flecks of black on the first two rows of dorsal scales, and the latter in not more than 15 rows.

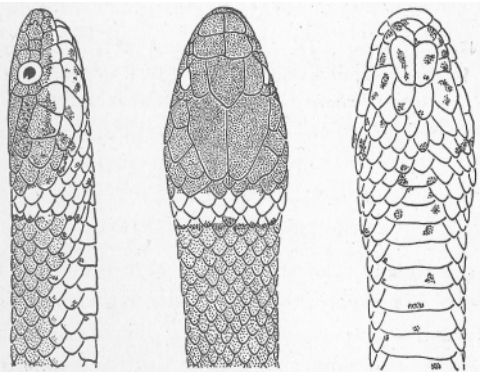


Fig. 4. *D. a. occidentalis,* MVZ 7260 (Type), Bridgeville, Humboldt County, Calif.

Scutellation.—The 28 specimens examined present the following scalation: ventrals 182 to 210 (males 182-201, av. 188; females 197-210, av. 204); caudals 55 to 67 (males 63-67, av. 65; females 55-59, av. 57); upper labials 7, occasionally 8; lower labials 8, occasionally 7; preoculars 2; postoculars 2; temporals 1+1 (in one specimen 1+2); posterior chin

shields in contact, narrower and shorter than the anterior pair; scale rows 15-15 or 15-13.

Form and Size. The bodily proportions seem to be about the average for the subspecies of *amabilis.* The tail varies from .165 to .221 of the total length (males .201-.221, av. .209; females .165-.190, av. 174) . The largest specimen examined measured 594 mm. and was a female from Willamette Valley, Oregon. For lengths of all specimens see Fig. 5.

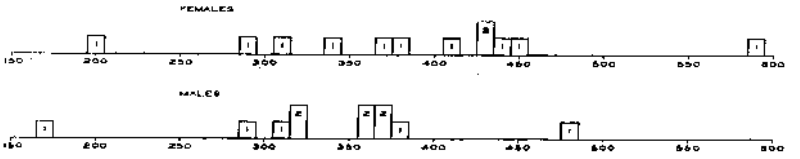


Fig. 5. Distribution by size (total length to nearest 10 mm.) and sex of 23 specimens of *D. a. occidentalis.*

Coloration. The coloration, judging from preserved specimens, is light or dark slate above, and as far down on the sides as the top or the middle of the second row of scales. The lower surface is yellow becoming reddish posteriorly, and lightly sprinkled with black spots. The light colored rows of dorsal scales are more or less flecked with black (but in one specimen these spots are practically absent) . The neck ring is conspicuous, uninterrupted, from one and one-half to two scales in width and bordered behind with a narrow black band or row of black spots. The top of the head is darker than the general dorsal surface, the chin and labials, especially the lower labials, are prominently spotted with black. The ventral color in life is undoubtedly like that of the other forms of *amabilis,* a brilliant scarlet or orange.

Dentition. The maxillary teeth, counted in five specimens, are 11 in half of the instances and 12 in the other half; the most anterior are a little smaller than those in the middle, and the last two are decidedly larger and are set off from the first 9 or 10 by a distant gap.

HABITAT AND HABITS

On this subject there appear to be no records for *occidentalis.*

[Fitch (1936, p. 644) , writing of this subspecies in the Rogue River basin, Oregon, states that it was found in low Transition or Upper Sonoran life zones usually near water; one was taken crossing a road, another in a dry irrigation ditch, a third under the edge of a bush, another under a flat rock, and three crossing trails at midday. A large female

(MVZ 17246) collected May 15, 1934, contained four eggs averaging 20 mm. in length. Captives ate western skinks on several occasions. Graf *et al.* (1939, p. 103) mention a snake of this subspecies taken from the stomach of a bull frog collected at Oswego Lake, Clackamas County, Oregon.]

DISTRIBUTION

Range. Specimens at hand indicate that *occidentalis* occurs in the west coast mountainous region from somewhat north of San Francisco Bay to southern Washington (Map 1, p. 27) [and east to Boise County, Idaho (Uhler, 1940, p. 136)] .

MATERIAL EXAMINED

CALIFORNIA: ANSP 3462-4. *Butte* Co.—Berry Creek, MVZ 13797. *Contra Costa* Co.—San Pablo Point, MVZ 9349. *Eldorado* Co.—Whaler Creek, 2 mi. W. of Soap Weed, MVZ (1) . *Humboldt* Co.—Bridgeville, MVZ 7260 (Type); Mattole River at Woods Creek, MVZ 18633. *Lake* Co.—Lakeport, MVZ 12468-9. *Mendocino* Co.—Manzanita, CAS 41696; Ukiah, USNM 20916. *Napa* Co.—Calistoga, USNM 52661, STANFORD 4179; Las Posadas State Forest, Moore Creek, 10 mi. E. of St. Helena, MVZ 18010. *Solano* Co.—Vacaville, MVZ 3989. *Sonoma* Co.—Camp Royaneh, near Cazadero, LMK 9238-40; Monte Rio, MVZ 6742; Petaluma, USNM 2070; Staggs Springs, CAS 28030-3. *Trinity* Co.—Mad River (2400 ft.), MVZ 12242. *Yolo* Co.—Woodland, CAS (1).

OREGON: Willamette Valley, ANSP 10785. *Curry* Co.—Burns Creek, 1 mi. E. of Lobster Creek, and Paradise Bar, all on N. side of Rogue River, MVZ 17246, 17247, and 17248 respectively. *Hood River* Co.—Hood River, MVZ 18009; W. of Hood River, USNM 38382. *Jackson* Co.—Jacksonville, MVZ 16327. *Klamath Co.—Upper* Klamath Lake, CAS 63717. *Wasco Co.—Ft.* Dalles, USNM 7285; on Columbia River Highway, 100 mi. E. of Portland, LMK 5557.

WASHINGTON: *Clarke* Co.—Camas, REED (1). *Klickitat* Co.—Goldendale, OREGON (1) . *Whitman* Co.—Wawawai, WASH. (1) .

[Additional records, recently published, are the following: IDAHO: *Boise Co.*-5 mi. SW. of Horseshoe Bend, Uhler (1940, p. 136). OREGON: *Benton Co.*—Corvallis, *Clackamas* Co.—Oswego Lake, *Douglas* Co.—Sutherlin, *Linn* Co.—Peterson Butte, Graf *et al.* (1939, p. 103); *Jackson* Co.—Belmont Orchard (6 mi. S. of Medford), Dark Hollow (7 mi. S. of Medford), Fitch (1936, p. 644). WASHINGTON: *Cowlitz* Co.—Kalama, *Whitman* Co.—Colfax, Svihla (1938, p. 47).]

VARIATION

The locality records for this form show a wide gap between Humboldt County, California, and northwestern Oregon. Before the status of *Diadophis* in this northwesternmost part of its range can be satisfactorily determined, numerous additional specimens must be obtained from here and from other parts of western Oregon. The Fort Dalles specimen seems to be like the California examples, but the Hood River

specimen is much more heavily and numerously spotted below. Like the latter is the one from Willamette Valley, Oregon. This specimen* (ANSP 10785) is labeled "O. B. Johnson, Cope Collection." It has the belly well spotted with rather large spots; there is a black tip on the posterior end of nearly every dorsal scale of the first row; the postero-dorsal third of the second row of scales is dark like the upper surface, while the rest of this row is unmarked. The chin is heavily spotted. Three specimens in the collection of the Oregon State Agricultural College at Corvallis are typical of *occidentalis.* Two of these specimens lack locality data, but a tag on one of them bears a date of collection and it is reasonable to suppose that they were collected somewhere in that region. The third specimen is accompanied by complete data showing it to have been obtained a little north of the Columbia River.

The sum of the evidence favors the view that *occidentalis* accurs in typical form to the northern limit of its distribution.

AFFINITIES

This form is evidently closely allied to both *pulchellus* and *vandenburghi.* It occupies a position geographically as well as structurally midway between the two. Like *vandenburghi* its neck ring is prominent and not interrupted, and it has a sparsely spotted ventral surface, the light color of which extends well up onto the sides, from one and one-half to two scale rows, and these latter are more or less specked with black. In *pulchellus* the neck ring is carried to the extreme width among the forms of *amabilis,* the black spotting of the lower surfaces is the most reduced and the ventral color extends highest upon the sides.

With *amabilis* this form is less closely allied in structure than it is with *vandenburghi,* and yet it evidently intergrades with it. The conditions would be met if *amabilis* had extended its range westward into the San Francisco Bay region subsequent to the time when *occidentalis* attained its present position.

***Another specimen with the same data (ANSP 10780) I have not included in the list of *occidentalis* because it is distinctly unlike the others known from this region. The ventral color does not extend onto the dorsal scales, except a little at the extreme anterior end; the belly is prominently marked with irregularly placed half-moon spots, the chin is heavily spotted; there is a large dark spot on each end of each ventral plate. The scales are in 17 rows throughout the body length; the ventrals are 194; caudals 51; upper labials 7; right lower labials 8, left 9; oculars 2; temporals 1+1; the neck ring is one and one-half scales wide and partly interrupted. It is a female, 168 mm. long, with tail 27 mm. in length. The writer believes this to he a *D. amabilis modestus* with erroneous locality label.**

Diadophis amabilis pulchellus (Baird and Girard)

Sierran Ring-neck Snake

Fig. 6

1853. *Diadophis pulchellus* BAIRD AND GIRARD, Cat. N. Amer. Rept., p. 115 (Type locality El Dorado County, California; type specimen deposited in the U. S. National Museum, now apparently lost; C. C. Boyle, collector).-BAIRD, Pac. R. R. Surv., vol. 10, 1859, pt. 3, Rept., pl. 33, *fig.* 85; *ibid.*, pt. 4, no. 4, Williamson-Abbott Surv., p. 11.-STEJNEGER, N. Amer. Fauna, no. 7, 1893, p. 203.

1859. *Ablabes punctatus, (pulchellus)* HEERMAN, *in* Hallowell's report on reptiles of Williamson's Route, Pac. R. R. Surv., vol. 10, pt. 4, no. 1, p. 24.

1882. *Diadophis punctatus pulchellus* YARROW, Bull. U. S. Nat. Mus., no. 24, p. 15, 96; Smiths. Misc. Coll., no. 517, 1883, p. 15.-COPE, Proc. Acad. Nat. Sci. Philadelphia, 1883, p. 23, 27.-DUMERIL AND BOCOURT, Miss. Sci. Mex., pt. 2, 1886, p. 620.-TOWNSEND, Proc. U. S. Nat. Mus., vol. 10, 1887, p. 239.

1892. *Diadophis amabilis pulchellus* COPE, Proc. U. S. Nat. Mus., vol. 14, p. 616; Amer. Nat., 1896, p. 1019; Ann. Rep. U. S. Nat. Mus. (1898), 1900, p. 747, *fig.* 157.-BLANCHARD, Occ. Papers Mus. Zool. Univ. Mich., no. 142, 1923, p. 8.-STEJNEGER AND BARBOUR, Check List, ed. 2, 1923, p. 82.-BLANCHARD, Papers Mich. Acad. Sci., Arts, Let., vol. 4 (1924), 1925, pt. 2, p. 36.-STEJNEGER AND BARBOUR, Check List, ed. 3, 1933, p. 89; ed. 4, 1939, p. 98.

1897. *Diadophis amabilis* (part) VAN DENBURGH, Occ. Papers Calif. Acad. Sci., no. 5, p. 166.-GRINNELL AND CAMP, Univ. Calif. Publ. Zool., vol. 17, 1917, no. 10, p. 186, fig. 12 (part).-VAN DENBURGH, Occ. Papers Calif. Acad. Sci., no. 10, 1922, p. 650 (part).

1924. *Diadophis amabilis amabilis* GRINNELL AND STORER, Animal Life in the Yosemite, p. 639.

DESCRIPTION

Diagnosis. The salient features of this form are a broad, uninterrupted neck ring, 2 to 3 scales wide; the ventral color extending immaculately over the two lowermost rows of dorsal scales; black spots on belly few and small, or absent; and dorsal scales in only 15 rows.

Scutellation.—The scutellation following is based upon only 11 specimens in addition to the description of the type: ventrals 181-194 (av. 184) in males, and 196-205 (av. 203) in females; caudals 64-76 (av. 69) in males, and 59-62 (av. 61) in females; upper labials 7 (rarely 8 or 6); lower labials 7 or 8; preoculars 2; postoculars 2; temporals 1+1; posterior chin shields in contact, a little shorter and narrower than the anterior pair; dorsal scale rows 15-15 or 15-13.

Form and Size. —The body is moderately thick in proportion to its length as compared with the other subspecies of *amabilis*. The tail length in relation to the total length varied in five males from .202 to .229 (av. .215) of the total length, and in two females it was .185 and .196 of

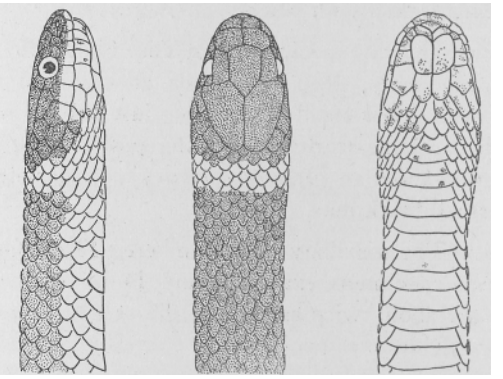


Fig. 6. *D. a. pulchellus*, MZUM 90907, Yosemite Park, Mariposa County, Calif.

the total length. The largest specimen examined, a male, measured 475 mm. and came from Yosemite Valley, California. Four out of six other specimens were more than 400 mm. long (Fig. 7).

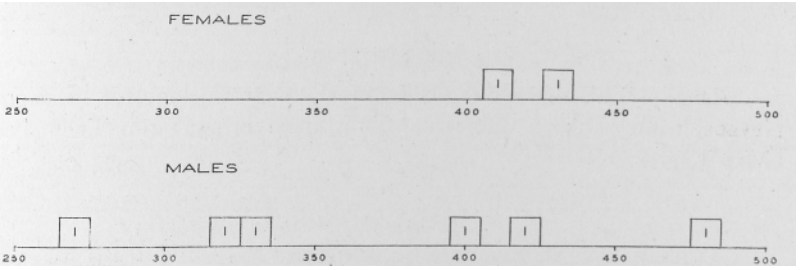


Fig. 7. Distribution by size (total length to nearest 10 mm.) and sex of 8 specimens of *D. a. pulchellus*.

Coloration.- The upper surface in adults seems to be a light blue-gray. This extends down on the sides only as far as the top of the second scale row where it is suddenly replaced by the ventral color. The latter is probably bright orange or orange red in life. The two lower rows of dorsal scales are not flecked with black. The spots on the belly are very small; in some specimens they are very few and in others they are fairly numerous. One specimen (MZUM 60907) has a row of minute black spots along the ends of the ventrals on the posterior third of the

body, and these continue along most of the caudals. The neck ring is broad and conspicuous, varying from 2 to 3 scales in width, and is very narrowly bordered with black. The top of the head seems to be darker than the general dorsal surface. The lower labials and chin shields may be more or less specked with black.

The colors of a living specimen from Yosemite Valley (MZUM 60907) were as follows: glossy, deep slate-green above; head much darker, almost black, with a few small black spots just behind neck ring; most of belly nearly a Flame-scarlet, darkening posteriorly to Scarlet-red or darker; neck ring about an Orange-chrome; belly sparsely and irregularly spotted with small black dots.

Dentition.—The maxillary teeth numbered 12 on one side and 13 on the other in two specimens examined and 14 on each side in a third. The last two are about twice as large as the preceding and are separated from them by a wide interspace.

HABITAT AND HABITS

For this form apparently nothing definite has been published on this subject. Dr. Robert T. Hatt found a specimen September 15, 1922, in a dry pine forest, one mile east of Yosemite in Yosemite Valley, California.

DISTRIBUTION

Range.—This subspecies occurs on the western slopes of the Sierra Nevada, from northern California south, apparently as far as Tejon Pass (Map 1, p. 27).

MATERIAL EXAMINED

CALIFORNIA: Mc Cloud River, ANSP 10798. *Amador* Co.—Oleta, LMK 294, 643. *El Dorado* Co.—Placerville, MVZ 18020. *Mariposa* Co.—Yosemite Valley, USNM (1), STANFORD 1690; Yosemite Park, MZUM 60907; Varian, MVZ 1624. *Shasta* Co.—Baird, USNM 11804, 13798. *Tuolumne* Co.—Camp Tuolumne, MVZ 9476.

Records in addition to those in the list of specimens examined are as follows: Tejon Pass, California (Heerman, 1859, p. 24) and El Dorado County, California (Baird and Girard, 1853, p. 115).

AFFINITIES

This form can be allied closely only with *vandenburghi* and *occidentalis*, the two western races presenting the greatest reduction in the black spotting of the belly and the greatest encroachment by the ventral color

on the dorsal scales. These three, furthermore, agree in the conspicuous, uninterrupted neck rings. The relationship of *pulchellus* with these other two races is, however, not equal. In each of the characteristics mentioned *pulchellus* exhibits the greatest development, *occidentalis* the next, and *vandenburghi* the least. From the latter *pulchellus* also differs in number of scale rows, and it is farther removed from it geographically.

Diadophis amabilis amabilis (Baird and Girard)

Western Ring-neck Snake

Fig. 8

1853. *Diadophis amabilis* BAIRD AND GIRARD, Cat. N. Amer. Rept., p. 113 (Type locality San Jose, California; type specimen USNM 2061, J. L. Le Conte, collector); Proc. Acad. Nat. Sci. Philadelphia, 1853, p. 300.-BAIRD, Pac. R. R. Surv., vol. 10, 1859, Rept., pl. 33, *fig.* 83.-VAN DENBURGH, Occ. Papers Calif. Acad. Sci., no. 5, 1897, p. 164 (part).-BROWN, Proc. Acad. Nat. Sci. Philadelphia, 1901, p. 70.-STEJNEGER AND BARBOUR, Check List, 1917, p. 75 (part).-DITMARS, Reptile Book, 1907, p. 337 (part).-GRINNELL AND CAMP, Univ. Calif. Publ. Zool., vol. 17, no. 10, 1917, p. 186 (part), fig. 12.-VAN DENBURGH, Occ. Papers Calif. Acad. Sci., no. 10, vol. 2, 1922, p. 648 *(part).-Coronella amabilis* (part) BOULENGER, *Cat.* Snakes Brit. Miss., vol. 2, 1894, p. 207 (Santa Cruz) .

1875. *Diadophis punctatus amabilis* (part) COPE, Bull. U. S. Nat. Mus., no . 1, p. 37.-JORDAN, Man. Vert., 1876, p. 180.--SMITH, Geol. Surv. Ohio, vol. 4, 1882, p. 697 (part).-YARROW, Bull. U. S. Nat. Mus., no. 24, 1882, p. 15, 95. -GARMAN, S., Mem. Mus. Comp. Zool., vol. 8, no. 3, 1883, p. 159.-YARROW, Smiths. Misc. Coll., no. 517, 1883, p. 15.

1900. *Diadophis amabilis amabilis* COPE, Ann. Rep. U. S. Nat. Mus. (1898), p. 749, *fig.* 160.-BLANCHARD, Occ. Papers Mus. Zool. Univ. Mich., no. 142, 1923, p. 3, 8.-STEJNEGER AND BARBOUR, Check List, ed. 2, 1923, p. 82.-BLANCHARD, Papers Mich. Acad. Sci. Arts, Let., vol. 4 (1924), pt. 2. 1925, p. 35.-STEJNEGER AND BARBOUR, Check List, ed. 3, 1933, p. 88; ed. 4, 1939, p. 97.

DESCRIPTION

Diagnosis. This form is characterized by a narrow neck ring that is sometimes interrupted; by 15 rows of scales, often changing to 13 at the posterior end of the body; by the ventral color extending usually onto the lower part of the second row of dorsal scales; by numerous small black spots scattered over the belly; and by slender proportions and moderate length.

Scutellation.—The following account of the scutellation is based upon the examination of 62 specimens: ventrals 183 to 211 (males 183-201, av. 191; females 196-211, av. 204); caudals 51 to 70 (males 59-70, av. 63; females 51-63, av. 56) ; upper labials 7, occasionally 8, rarely 6;

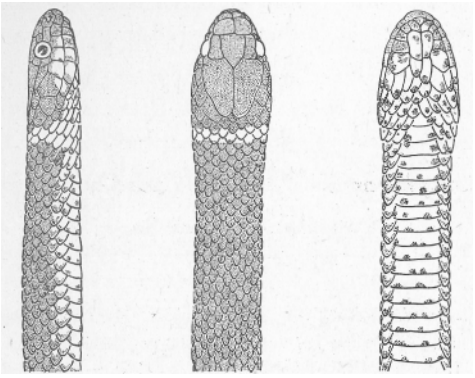


Fig. 8. *D. a. amabilis,* MZUM 60901, Stanford University, Santa Clara County, Calif.

lower labials 8, rarely 7; preoculars 2, in one instance 1; postoculars 2, rarely 1 or 3; temporals 1+1 (except anterior temporal missing in one specimen); posterior chin shields in contact, about the same length as anterior pair, and but little if any narrower; dorsal scale rows 15 throughout the body length, or 15-13 (16-17-15 in a single instance).

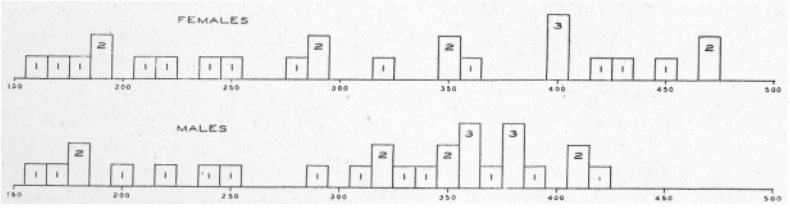


Fig. 9. Distribution by size (total length to nearest 10 mm.) and sex of 51 specimens of *D. a. amabilis.*

Form and Size.—In the majority of specimens the body is noticeably slender in proportions although an occasional individual attains the length and proportions of a *modestus* or *pulchellus.* The tail varies from .151 to .218 of the total length (males .176-.218, av. .200; females .151-.193, av. .170) . The largest specimen examined measured 474 mm. in length and was a female from Berkeley, California. Total lengths of all specimens are shown in Fig. 9.

Coloration.—The color in preserved specimens is generally a blackish slate above, sometimes light gray and sometimes almost black. The top of the head is darker than the rest of the body. The color below is generally yellow, often becoming reddish posteriorly and under the tail. This color extends over from one-half to one and one-half of the lowermost rows of dorsal scales. The lower surfaces are always more or less strongly spotted with black. The lower light colored dorsal scales are marked with black, particularly on their tips. The ventral black spots are more commonly rounded, but individuals fairly often show the transversely elongated spots on the ends of the ventrals that are more conspicuous on *modestus.* The neck ring is narrow, commonly about one scale wide, although varying from one-half to one and one-half scales in width, and interrupted in the median line in 25 per cent of the specimens examined.

The colors of a living specimen from Stanford University were noted as follows: dorsal scales a dusty, Neutral Gray with inconspicuous minute mottling of lighter; top of head black, without mottling, the black extending over most of the upper labials; parts of chin and gular scales, lower labials, and lower parts of middle upper labials an Apricot Orange mixed with grayish and with scattered black spots, ventral scales a little darker than Flame Scarlet anteriorly, becoming posteriorly and under the tail nearly a Scarlet or a little darker; numerous black spots on the ventral scales; neck ring nearly a Brazil Red, becoming lighter below; tongue and pupils dark.

Dentition. The dentition, as determined from the examination of a few specimens, is as follows: maxillary teeth 11 or 12, the last two about twice as large as the preceding and separated from them by a relatively wide interspace; mandibular teeth about 16 to 18; palatine teeth about 7 to 9; pterygoid teeth about 16 to 19.

HABITAT AND HABITS

On this subject there is but little recorded. Van **Denburgh** (1897, p. 166), referring probably to this form, says that it is "most often found under boards or logs in moist localities, sometimes even in salt marshes. Its food probably consists chiefly of insects, but one specimen had eaten a half-grown tree-toad *(Hyla regilla)*." One specimen examined by the writer had eaten a salamander three inches long. A few notes recorded with specimens are as follows: "under rock, Indian burying ground, North Berkley"; "hill near Christy, 200 feet, Contra Costa County"; "Chambers Ravine, 4 miles north of Oroville, Butte County, 600 feet"; "Red-

wood Canyon, Contra Costa County"; "La Loma and Cedar Streets, Berkeley"; "Lagunitas Creek, 300 to 400 feet, Marin County."

Sexual maturity in males is attained at a length of about 300 mm.; only males longer than this, in the specimens examined, possessed anal ridges.

DISTRIBUTION

Range. The range of *amabilis* may be defined in a general way as the region of San Francisco Bay and the foothills of the San Joaquin and Sacramento River valleys (Map 1, p. 27) . It apparently belongs to lower elevations than *pulchellus.* The specimens at present in collections represent so few localities that the geographic relationships of the ring-neck snakes in northern California can only he surmised.

MATERIAL EXAMINED

CALIFORNIA: *Alameda* Co.-Berkeley, CORNELL 1323, MVZ 1632, 3560, 4741, 4795, 9459, 9466-8, 10521-2, 13982, 14947, 16070, 18008, USNM 13936; localities near Berkeley: North Berkeley, MVZ 2435, Berkeley Hills, MVZ 5413, 5553, Woolsey Canyon, MVZ 16584, Strawberry Canyon, MVZ 16599, Greek Theater, MVZ 17599, and Leona Heights, USNM 52197; Niles Canyon, MVZ 16945. *Butte* Co.-Oroville, MVZ 3988; Berry Creek, MVZ 13797. *Contra Costa* Co.-Cristy, MVZ 2475; Crockett, MVZ 12266; Lafayette, MVZ 16055; Redwood Canyon, MVZ 5412. *Fresno* Co.-Friant, MCZ 8897; Fresno, USNM 11786, 11802. *Lake* Co.-Lakeport, MVZ 12468-9; Manley Ranch, 4 mi. SW. of Lakeport, MVZ 14941. *Marin* Co.-Lagunitas, CAS 27327-9, MVZ 6104, USNM 59286; Mount Tamalpais, MVZ 16054; Mill Valley, CAS 65960; San Rafael, MVZ 7178. *Mariposa* Co.-Mariposa, STANFORD 4226. *San Francisco* Co.-San Francisco, ANSP 3461. *San Mateo* Co.-Skyline Blvd., above Millbrae Highlands, MVZ 16053. *Santa Clara* Co.-Los Gatos, MVZ 8229; 4 mi. SW. of Los Gatos, MVZ 16048; Palo Alto, FMNH 709, MCZ 6603-4, 8164, STANFORD 1213, 4178, 4195-6; Stanford University, MZUM 60901-5, STANFORD 6438-9, 7185-8, 7191-3, USNM 50721; San Jose, MCZ 743, 2060, USNM 2061; Saratoga, MVZ 10361. *Santa Cruz* Co.-Aptos, CAS 63775; Ben Lomond, MVZ 8828; Brookdale, MZUM 51765; Loma Prieta, CAS 66308. *Tulare* Co.--Paradise Creek Trail, Sequoia Nat. Park, 3600 ft., MVZ 18010 (?);
LMK 8052.

Ring neck snakes have been reported from numerous localities in California from which the writer has seen no specimens (Van Denburgh, 1922, p. 650-651) . Some of these records are probably based on *amabilis,* and some refer evidently to other subspecies.

VARIATION

The concentration in the San Francisco area of the bulk of specimens on which this study was based precludes, for the present, the study of geographic variation. An interesting individual variation is the finding

of two specimens, out of the 62 examined, with the anal plate entire. A tabulation of scale formulas by sex shows that just half the males (16) have the formula 15-15 and the other half the formula 15-13, while of the females the ratio of the higher formula to the lower is 18 to 8, or about two to one. This agrees with the general rule in snakes, that females tend to have a higher scale formula than males, particularly at the posterior end of the body.

AFFINITIES

D. a. amabilis is obviously closely related to the other races of ring-neck snakes in California. Although it probably intergrades with those to the east and to the west, its closest relatives are apparently to the south, and, surprising though it may seem, it is most like *similis*. The scale formulas 15-15 and 15-13 are more common in *amabilis* and *similis* than in any of the other members of the *amabilis* group. *Amabilis* differs from *similis* chiefly in the extent of the encroachment of the ventral color onto the dorsal scales, and in the smaller percentage of specimens with the scale formula 15-13.

A more complete discussion of relationships will be found in the summary of the *amabilis* group.

Diadophis amabilis similis Blanchard

San Diegan Ring-neck Snake

Fig. 10

1892. *Diadophis amabilis amabilis* COPE, Proc. U. S. Nat. Mus., vol. 14, p. 616; Amer. Nat., 1896, p. 1017.

1894. *Coronella amabilis* BOULENGER, Cat. Snakes Brit. Mus., vol. 2, p. 207 (San *Diego).-Diadophis amabilis* HURTER, 1st Ann. Rep. Laguna Marine Lab. , 1912, p. 67, (?).-ATSATT, Univ. Calif. Publ. Zool., vol. 12, 1913, no. 3, p. 41.-STEPHENS, Trans. San Diego Soc. Nat. Hist., vol. 3, 1921, no. 4, p. 64. -GRINNELL AND CAMP, Univ. Calif. Publ. Zool., vol. 17, 1917, no. 10, p. 186 (part), fig. 12.-VAN DENBURGH, Occ. Papers Calif. Acad. Sci., no. 10, 1922, vol. 2, p. 651.-SCHMIDT, Bull. Amer. Mus. Nat. Hist., vol. 46, 1922, art. 11, p. 689.

1923. *Diadophis amabilis similis* BLANCHARD, Occ. Papers Mus. Zool. Univ. Mich., no. 142, July 9, p. 4, 8 (Type locality San Diego, California; type specimen MZUM 57897, collected by L. M. Klauber in 1923).-STEJNEGER AND BARBOUR, Check List, ed. 2, 1923, p. 82.-BLANCHARD, Copeia, no. 130, 1924, p. 56. -KLAUBER, Bull. Zool. SOC. San Diego, no. 1, 1924, p. 9.-BLANCHARD, Papers Mich. Acad. Sci. Arts, Let., vol. 4 (1924), 1925, pt. 2, p. 35.-KLAUBER,

Copeia, no. 155, 1926, p. 144; Bull. Zool. Soc. San Diego, no. 4, 1928, p. 4; *Ibid.*, no. 5, 1930, p. 4; *Ibid.*, no. 8, 1931, p. 9 *et* al.—STEJNEGER AND BARBOUR, Check List, ed. 3, 1933, p. 89; ed. 4, 1939, p. 98.

DESCRIPTION

Diagnosis.—The chief characteristics of this form are the moderately black-spotted belly, the dorsal scale formula usually 15-13 but occasionally 15-15 (20 per cent of females), the light color of the ventral surface extending over only from one third to two thirds of the first row of dorsal scales, and the generally light olive color of the upper surface.

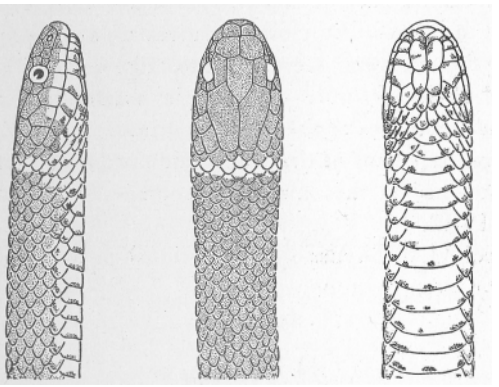


Fig. 10. *D. a. similis,* MZUM 57897 (Type), San Diego, Calif.

Scutellation.—The following scutellation is based upon 225 specimens (data on 139 of which were kindly supplied by L. M. Klauber of San Diego, California) : ventrals 183-209 (males 183-207, av. 194; females 191-209, av. 201); caudals 48 to 68 (males 54-68, av. 61; females 48-60, av. 53); upper labials 7, rarely 8; lower labials 8, rarely 7; preoculars 2, occasionally 1; postoculars 2, rarely 1; temporals 1+ 1; posterior chin shields in contact, generally a little narrower and a little shorter than the anterior pair; scale rows 15-13 (males and most females), occasionally 15-15 (one fifth of the females), rarely 17-15.

Form and Size.—This subspecies has a long, slender body, like the other forms of *amabilis* (except *anthonyi)* . The tail varies from .122 to .207 of the total length (males .172-.207, av. .192; females .122-.188, av. .168) . The largest specimen measured 524 mm. in total length and is a female from the San Pedro Martir Mountains (US NM 37526). The next largest is a female from Temecula, Riverside County, California,

that measured 477 mm. The smallest specimen measured 142 mm., and in this specimen the umbilicus was not healed. The markedly greater length of the San Pedro Martir specimen is suggestive of a different subspecies, but the single specimen we have from that region appears to present no other divergence from the San Diegan representatives of *similis*. The latter may indeed grow much larger than any in the collections examined. Total lengths of all specimens for which data were at hand are diagrammed in Fig. 11. From this figure it is evident that females tend to larger sizes than males.

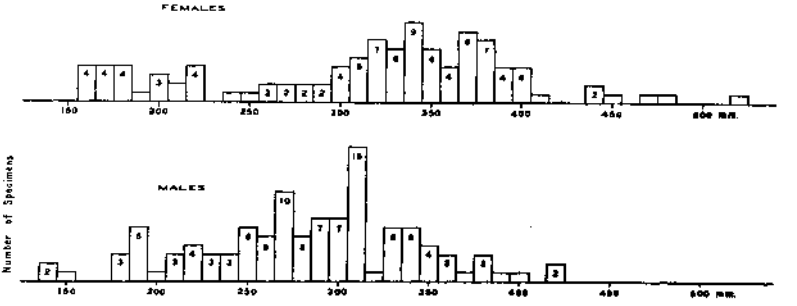


Fig. 11. Distribution by size (total length to nearest 10 mm.) and sex of 212 specimens of *D. a. similis*.

Coloration. The coloration of living adults is, in brief, as follows: body and tail olive above; head darker to blackish above, below pale yellow, spotted with black; neck ring dull red, bordered behind with a few black dots; belly orange-yellow, changing to scarlet a little in front of the anus, and continuing scarlet under the tail. The belly is rather sparsely or prominently spotted with black, but on the ends of each ventral scute is a black dash forming on each side a ventrolateral row of black spots throughout the length of body and tail. The tail is commonly not otherwise marked below. Labials, chin, and throat are spotted with black. Young individuals are much darker above. Occasional specimens have no spots below, except on the ends of the ventrals.

The colors of living adults from San Diego, California, in terms of Ridgeway's Color Standards are as follows: Olive to Vetiver Green to Dark Olive-gray above; top of head Dark Olive-gray to Olivaceous Black; neck ring Scarlet to Mars Orange; belly Orange-buff to Cadmium Orange; under side of tail usually Brazil Red to Peach Red.

The coloration of preserved specimens is nearly an olive gray above and pale yellow below. The top of the head is darker, and the neck ring is yellow.

Dentition. The maxillary teeth are 11 or 12 in five specimens counted. The anterior four or five teeth are the smallest, and the last two are the largest. The latter are separated from those preceding by a distinct interspace.

HABITAT AND HABITS

For information on this subject we are indebted principally to L. M. Klauber of San Diego, California. He summed up the status of this form in 1928 (p. 4; also 1930, p. 4) as "moderately common from the ocean to the mountains, particularly in gardens or other moist places." His records and statistics covering the eight years from 1923 to 1930, inclusive, show this species to be eighth in order of abundance of the twenty-nine species of snakes known in San Diego County, and to comprise 4.4 per cent of all the snakes identified in these years. In this eight-year period Klauber reports 274 specimens, distributed by months as follows: 9 in January, 26 in February, 42 in March, 44 in April, 48 in May, 28 in June, 21 in July, 13 in August, 15 in September, 14 in October, 9 in November, and 5 in December (1931, p. 12). By far the greater number of specimens came from the coastal regions (82.4 per cent) , but small numbers were found in the inland valleys and foothills and a single specimen in the mountains. The only other mountain record is that of Atsatt (1913, p. 41) for the capture of a specimen in Strawberry Valley, San Jacinto Mountains (MVZ 3801), at an elevation of 5500 feet. It was found crossing a road in the afternoon. None have been taken in the deserts or desert foothills. Klauber refers to the ring-neck snake as a burrowing species, most active in the daytime. The latter point was verified by specimens kept by the writer in an outdoor enclosure. One or more individuals could frequently be observed at midday.

Ability to withstand a far colder climate than that of San Diego was demonstrated by some specimens of this form sent to the writer by Mr. Klauber in the spring of 1924. Six of these were put in a large cement enclosure out-of-doors at Ann Arbor, Michigan. At least one of these snakes was seen in April, 1925, and appeared to be in good condition. It had withstood the winter with only a cold-frame sash for protection.

When handling these snakes alive and confining the head, as for examining the head scutellation, a clear, somewhat viscous fluid oozes from the mouth in some abundance. The habit, when annoyed, of throwing the tail into a spiral with red lower surface uppermost is pronounced in this species. Klauber mentions a specimen that would lie on its back and play dead (1931, p. 68) .

Its food according to Stephens (1921, p. 64) consists of earthworms, salamanders, and probably insects.

It is possible that adult females are in general larger than the males, at least this is suggested by the series of specimens examined. A plotting of the total lengths of 109 males and 103 females (Fig. 11) shows that the lengths of most of the females lie between 320 mm. and 400 mm. while most of the males measure from 250 mm. to 350 mm.

Males become sexually mature at a length of about 270 mm., judging from the anal ridges. These structures were not observed in males shorter than 270 mm., and from this length onward all but four specimens possessed them. These four measured 271, 279, 308, and 376 mm.

DISTRIBUTION

Range. Specimens here referred to this form have been taken in southwestern California west of the deserts, from southwestern San Bernardino County south to San Matias Pass in the San Pedro Martir Mountains and San Martin Island, Baja California (Map 1, p. 27).

MATERIAL EXAMINED

CALIFORNIA: *Riverside* Co.-Alessandro, STANFORD 5209-10; Banning, USNM 75173-4; Strawberry Valley, San Jacinto Mts., MVZ 3801; Temecula, LAM 647; Riverside, MCZ 7022. *San Bernardino* Co.-Slover Mt., Colton, MVZ 7175, 7264, 7405. *San Diego* Co.-BLANCHARD (12), LMK 177, SAN DIEGO ZOO (8), MZUM 63931-4, USNM 55106; between Carlsbad and Oceanside, STANFORD 4180; Chula Vista, SDS 1137; Deerhorn Flat, LMK 1264; Fallbrook, LMK 579; Flinn Springs, LMK 70; Jamul, SDS 1140; La Jolla, LMK 53, 1044, 1108; La Mesa, SDS 1495, LMK 822; Miramar, LMK 580; Mission Valley, LMK 239; Morena, LMK 231; Murray Dam, SDS 1139; Pine Valley, LMK 1140; Point Loma, LMK 97, SDS 1084-5; Rincon, MVZ 9470; San Diego, BLANCHARD (3), LMK 214, 268, 293-4, 426-7, 452, 647, 671, 677, 1026, 1045, 1109, 1141, 1155, MZUM 57897 (Type), SDS 1081-2, 1138, 1493; San Pasqual, LMK 1117; Santa Ysabel, SDS 1083; Warner's, SDS 1086; Witch Creek, USNM 20483-4; Wynola, SDS 1548.

BAJA CALIFORNIA: North end of San Pedro Martir Mts., USNM 37526; San Martin Island, USNM 23818.

In addition to the localities named in the list of specimens examined, the following records for San Diego County have been furnished by Klauber (1924, p. 9, and by correspondence) : Ballena, Chollas Heights, Dehesa, Descanso, Encanto, Encinitas, Lakeside, Lemon Grove, Ocean Beach, Otay Dam, Portrero, Ramona, San Onofre, San Pasqual, Spring Valley, Torrey Pines, and Vista. Van Denburgh (1922, p. 651) records it from Poway, San Diego County, and a specimen was collected at Laguna, Orange County, by Hurter (1912, p. 67), but since the latter specimen was not described it can not be identified with certainty as *similis*.

VARIATION

This form shows practically the same variation limits in numbers of ventrals and caudals as the other forms in the *amabilis* group. There seems to be greater consistency, however, in the low scale row formula of 15-13. Only one-fifth of 35 females and one out of 41 males from San Diego County have the formula 15-15. Near the range of *modestus* there is a tendency toward a higher formula. Thus, three out of five males from San Bernardino County have the dorsal scale rows 15-15; one male from Alessandro, Riverside County, has the scales 17-16-15, and another has them 15-15. These facts may be regarded as *evidence* of intergradation.

In view of the recognition of a closely related subspecies *(anthonyi)* on South Todos Santos Island, Baja California, it would seem likely that the specimen from San Martin Island* may represent as well a definable form. Since, however, the single specimen known seems to differ from *similis* only in the presence of 17 rows of dorsal scales for a brief space at the forward end of the body, it seems best to let this question await the acquisition of more material. The neck ring of this specimen is partly interrupted, as in *anthonyi,* and this is true also of the one from the San Pedro Martir Mountains. The latter has the scale rows 15-13-14.

In the series of specimens examined sex can be determined in most cases by subtracting the number of caudals from the number of ventrals. All specimens (40) in which this number was less than 138 were males, and all (29) in which it was more than 141 were females. In four males the number was from 138 to 141, and in three females it was 138 to 140. Sex is also rather definitely indicated in adults by the anal ridges in the males, as has been pointed out above.

The ventral color usually covers from one-half to two-thirds of the lowermost row of dorsal scales, but in occasional specimens there is, in addition, a light spot on a few of the anterior scales of the second row.

* San Martin Island lies 30 miles south of Cape Colnett, Baja California, and is nearly circular in form, with a diameter of about one mile. Near its center are two remarkable peaks, of which the southern, an extinct volcano 497 feet high, has a crater at its summit 350 feet in diameter and 40 feet deep. This island is quite barren, producing only the prickly pear and a few stunted bushes that grow among the loose masses of lava; it is surrounded by kelp and detached rocks, and is the resort of great numbers of seal and sea fowl, which are particularly numerous on the shores of the cove and the lagoon. *Mexico and Central America Pilot (West Coast),* Hydrographic Office No. 84, 6th ed., 1920, Washington, p. 44.

Certain occasional variations are evidently to be classed as abnormalities: the fusion of the lower preocular with the loreal; the fusion of a preocular with a prefrontal; the union of the loreal and the prefrontal; the fusion of the two preoculars and of the two postoculars; the junction of the sixth upper labial with the parietal; the union of the first temporal with the parietal; the occurrence of only 13 rows of scales throughout the greater part of the body length; and the presence of an undivided anal plate (which was the case in three males). These anomalies, all unusual, have been noted in from one to three instances in the series of 86 specimens examined by the writer.

AFFINITIES

This form seems to be most similar to *amabilis,* but so far as known their ranges do not meet. It apparently intergrades with *modestus,* its ally to the north, and its derivation from this race is quite conceivable. The evident differences between *similis* and *modestus* are (1) the number of scale rows is nearly always 17-15 in *modestus* and 15-13 in *similis;* (2) there is less of the ventral color on the first row of dorsal scales in *modestus;* (3) the figure obtained by subtracting the number of caudals from the number of ventrals is greater in *similis;* and (4) *similis* seems to be a smaller race. The question of relationship is discussed further in the general summary of the *amabilis* group.

Diadophis amabilis anthonyi (Van Denburgh and Slevin)

1923. *Diadophis anthonyi* VAN DENBURGH AND SLEVIN, Proc. Calif. Acad. Sci., ser. 4, vol. 13, no. 1, July 25, p. 1 (Type locality, South Todos Santos Island, Baja California, Mexico; type specimen CAS 56766, collected by Joseph R. Slevin, May 30, 192 3) .—STEJNEGER AND BARBOUR, Check List, ed. 3, 1933, p. 90; ed. 4, 1939, p. 98.

Diagnosis. Similar to *similis,* but larger and stouter-bodied; neck ring about one scale wide and poorly defined; belly heavily spotted with black bars on posterior edges of ventrals, extending from the lateral margins medially; yellow color of belly extending up onto about a third of the first row of scales; dorsal scale rows 15-15.

Scutellation. On the basis of the type series (two males and one female) the scutellation is as follows: ventrals (males) 182, 183, (female) 192, caudals (males) 63, (female) 34+; upper labials 7; lower labials

8; preoculars 2; postoculars 2; temporals 1+1; scale rows 15; posterior chin shields in contact and smaller than anterior.

Form and Size. The relative stoutness of this form is conspicuous. Measurements of the three specimens follow:

CAS 56764, female,	total length 470+ mm.;	tail 59+ mm.	(tail incomplete)
56765, male,	"	429 mm.	" 87 mm.
56766, male,	"	430 mm.	" 91 mm.

The ratios of length of tail to total length in the two males are .212 and .203 respectively.

Coloration. Through the kindness of Joseph R. Slevin the following notes on the coloration of the paratypes (CAS 56764-5) have been made available. General dorsal coloration (in alcohol) dark olive gray; top of head (parietal region) blackish brown; neck ring 1-2 scales wide, indistinct, yellowish brown, irregularly bordered on both sides with brownish black; ventral ground color pale yellow, becoming somewhat more intense posteriorly, and extending slightly upward on the anterior half of each scale of the lowest dorsal row; chin, lower labials and gulars with brownish black spots; a ventrolateral row of transverse black dashes on each side throughout the length of the body and tail as in *similis,* the dashes confined to the posterior lateral edges of the ventrals and caudals; the median portion of the belly only occasionally marked with dark spots.

Range. Apparently known only from the type locality, South Todos Santos Island, Baja California (Map 1, p. 27) .

Affinities. —Its geographic proximity and structural similarity indicate that *anthonyi* is closely related to *similis.*

SUMMARY OF THE *AMABILIS* GROUP

That the ring-neck snakes of the West Coast, from Washington to Baja California, form a homogeneous group distinct from all other forms in the genus is sufficiently evident in the constancy and distinctiveness of their ventral and caudal counts. Other characteristics they share to some extent with other forms of the genus, or vary in among themselves.

The group as a whole is clearly related to *laetus,* the *Diadophis* that is also nearest geographically. Of the seven races of *amabilis* one, *modestus,* stands out as obviously nearest to *laetus.* It shows this in its 17 rows of scales, smaller number of maxillary teeth, and slight encroachment of ventral color on the dorsal scales. But for *similis,* it is also nearest geographically to *laetus. Similis,* however, is more specialized than *modestus*

in directions already begun by that form, so that it is much more satisfactory to regard it as derived from *modestus* than from *laetus*. *Vandenburghi* is like *laetus* in its 17 rows of scales but is specialized in recession of the dorsal color up from the ventrals; and its geographic position also makes it less likely to be nearer to *laetus* than is *modestus*.

Granting *modestus* to be the connecting link with other Diadophis and therefore the most primitive member of the *amabilis* group, we may consider the interrelationships within this group.

To the northwest *modestus* changes into *vandenburghi* by the widening of the neck ring and a further recession of the dorsal color from the lower scale rows. Farther north *vandenburghi* changes into *occidentalis* by a reduction in scale rows from 17-15 to 15-15 and 15-13, by a reduction in the size of the black spots on the belly and lower sides. *Occidentalis* extends north through Oregon into southern Washington, but the very closely related *pulchellus* of the Sierra Nevada seems to be connected with it where the Sierra Nevada joins the Coast Range. *Pulchellus* has progressed beyond *occidentalis* in reduction of ventral pigmentation and in widening of the neck ring.

The line of evolution from *modestus* to *pulchellus* appears thus to show a definite trend throughout the group involving (1) reduction in scale rows from 17-15 to 15-15 with only a slight tendency to 15-13, (2) increase in number of maxillary teeth from an average of 11 to an average of 13, (3) extension of ventral color over the two lower rows of dorsal scales, (4) reduction in size of pigment spots on the lower surfaces, and (5) widening of the neck ring.

Two other members of the group, *amabilis* and *similis*, do not fit into this line of evolution. In spite of their resemblances to each other it is easier to regard them as independently evolved than as directly related, and to consider their similarities as in some way connected with their generally lowland habitat, which is in contrast with the habitat of the *modestus-pulchellus* line.

The range of *amabilis* is presumably in contact with that of each of the forms of the *modestus-pulchellus* line. It is central to the ranges of all these, but is best known in the general vicinity of San Francisco Bay, where its contacts are with *vandenburghi* and *occidentalis*. It could with reason be regarded as derived from either of these. Certainty it intergrades with *occidentalis* and it appears to do so with *vandenburghi*. Its relationship to *modestus* would be clearer if specimens were available nearer to the range of the latter, but it is not even certain that their ranges are in contact. Even if not in contact now it would not, of course, preclude their having been so at an earlier time.

A mabilis is not far removed from *modestus* in the considerable pigmentation of the lower surfaces, in the narrow neck ring, and in the limited encroachment of the ventral color on the dorsal scales. It is a smaller snake and the scale rows are definitely fewer. But that such a type as *amabilis* could come from such as *modestus* we can be fairly certain from the situation with regard to *similis*. This latter form differs from *amabilis* chiefly in the less extent of the ventral color on the dorsal scales and in the larger percentage of specimens with the scale formula 15-13.

Similis certainly intergrades with *modestus* along its northern boundary. Here we see how its widest structural difference, the number of scale rows, is bridged. The other differences are easily understandable as modifications from *modestus*.

The resemblances between *amabilis* and *similis* may be due to somewhat parallel divergence, north and south, from *modestus*. There is, at any rate, less difficulty in this conception than in trying to explain their divergence one from the other, or both from some hypothetical ancestor.

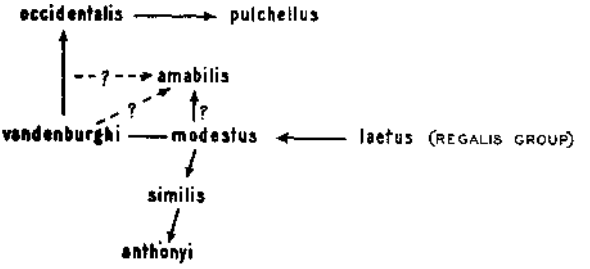


Fig. 12. Diagram representing probable relationships of the subspecies of *Diadophis amabilis*.

If it be taken that *amabilis* originated from *modestus*, then its intergradation with *vandenburghi* and *occidentalis* in the vicinity of San Francisco Bay may be interpreted as hybridization resulting from later contacts.

Pulchellus is, of course, too specialized to be given consideration as a possible ancestor of *amabilis*.

[By reason of its close structural similarity and its geographic position, *anthonyi* logically may he regarded as an insular derivative of *similis*.

The relationships here described are shown diagrammatically in Figure 12.

Diadophis dugesii (Villada)

Mexican Ring-neck Snake

Fig. 13

1865. *Diadophis ? stictogenys* COPE, Proc. Acad. Nat. Sci. Philadelphia, p. 197.

1868. *Liophis (Diadophis) arnyi* GUNTHER, Ann. Mag. Nat. Hist., ser. 4, vol. 1, p. 413.

1878. *Diadophis punctatus dougesii** VILLADA, La Naturaleza, vol. 3, p. 226, pl. (Type locality Balbuena, near Mexico City, Mexico; type specimen probably in Museo Nacional de Historia Natural in Mexico City) .—*Diadophis punctatus* var. *dugesii* HERRERA, La Naturaleza, ser. 2, vol. 1, 1891, p. 338.

1886. *Diadophis punctatus,* var. *laetus* DUMÉRIL AND BOCOURT, Miss. Sci. Mex., pt. 3, p. 622, pl. 40, fig. 4-4b.—AMARAL, Mem. Inst. Butantan, vol. 4, 1929, p 180

1887. *Diadophis punctatus arnyi* COPE, Bull. U. S. Nat. Mus., no. 32, p. *80.--Diadophis regalis arnyi* COPE, Proc. U. S. Nat. Mus., vol. 14, 1892, p. 615.

1893. *Coronella regalis* BOULENGER, Cat. Snakes Brit. Mus., vol. 2, p. 208.—MOCQUARD, Bull. Soc. Philom. Paris, ser. 9, vol. 1, 1899, no. 4, p. 156.

1893. *Liophis laetus* GUNTHER, Biol. Cent. Amer., Rept. and Batr., p. 108.—*Diadophis laetus* COPE, Amer. Nat., 1896, p. 1025.

DESCRIPTION

Diagnosis. This species is marked by dorsal scales being usually 17-17 or 17-19-17, the temporals 1+2, the ventrals 164 to 206, the upper labials 7 or 8, the neck ring broad, the dark color of the head extending prominently down across the angle of the jaw, the dorsal ground color usually extending over all the lowermost row of dorsal scales, and the lower surfaces being well sprinkled with small black spots.

Scutellation. —Knowledge of this form depends upon fifteen specimens examined in the present study and partial descriptions of a few more. The ventrals in ten males vary from 164 to 183 (av. 176), and in four females from 201 to 206 (av. 202) ; the caudals in eight males vary from 52 to 59 (av. 57) , in the females they are 49 to 53 (av. 51) ; the upper labials are 8 in six individuals and 7 in nine; the lower labials are 8 in all cases except for one side of one specimen which has 10; preoculars 2;

*[It has been brought to my attention by Dr. Hobart M. Smith that the original spelling of this name *(dougesii)* is either a *lapsus calami* or a typographical error which was corrected in the index of Volume 3 of *La Naturaleza* and also under "Erratas Notables del Tomo III." Furthermore, Dr. Alfredo Dugès, for whom the species was named, seems never to have spelled his name with an o.]

postoculars 2, except for 3 on one side in each of two specimens; temporals 1+2 in most cases, but 1+1 on one side in a few (only one has 1+1 on both sides); posterior chin shields a little shorter than anterior pair or about as long; scale rows 17-17 (except 17-19-17 in three specimens, 17-15 in one and 17-16 in another).

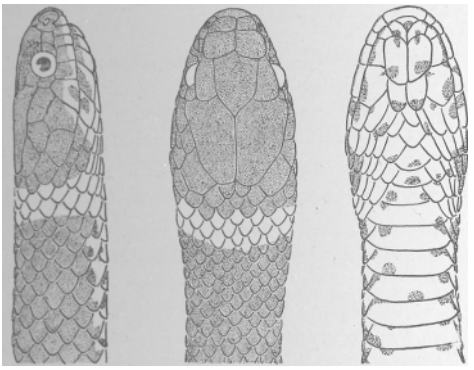


Fig. 13. *D. dugesii,* AMNH 19723, Ocotlan, Jalisco.

Form and Size. —This species is rather large for a *Diadophis.* The largest specimen examined measured 677 mm. in total length and was a female from Guanajuato. The smallest one seen by the writer was 271 mm. long. The tail length in seven males examined varied from .189 to .213 (av. .202) of the total length and in four females from .151 to .161 (av. .158).

Coloration. — The color above is dark and extends down over all the dorsal scales, or a few of the first row of scales at the anterior end may be of the ventral color. The neck ring is usually two scale-lengths wide or a little wider and not interrupted (in the material examined) . The dark color of the head extends around the angle of the jaw onto the gular scales. The lower surfaces of head and body are marked with small scattered dark spots. Those on the posterolateral corners of the ventrals and caudals are elongate; those on the posterior margins of the ventrals are strongly convex anteriorly. The lower margins of the upper jaws are light. No fresh specimens have been seen in the present study.

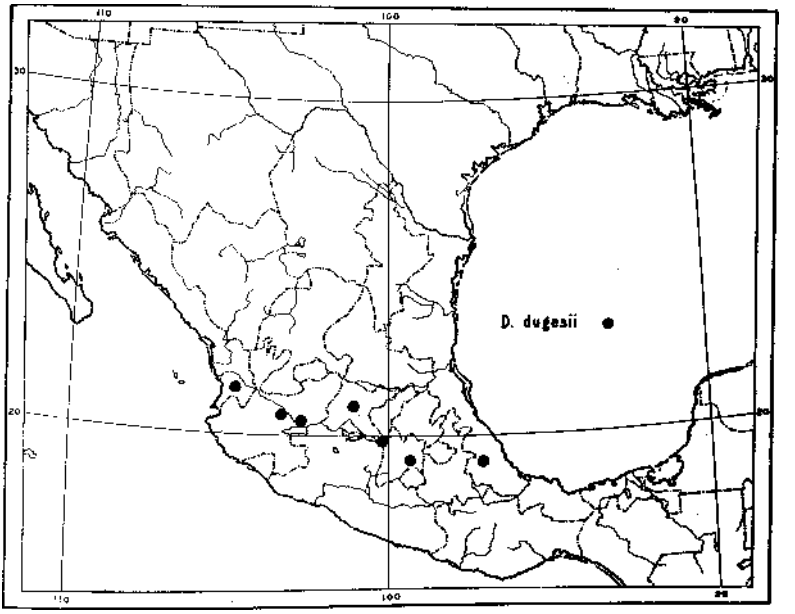
Dentition. —Examination of maxillary teeth in three specimens shows 11 in five jaws and 12 in one. The last two are about twice the size of those preceding, and are separated by a wide interspace.

HABITAT AND HABITS

Nothing of significance on this subject has been noted by the writer.

DISTRIBUTION

Range. The few scanty records indicate an east and west distribution from Nayarit and Jalisco to Veracruz (Map 2) . How far north and south the species extends can only be conjectured.



Map 2. Geographic distribution of the Mexican ring-neck snake, *Diadophis dugesii.*

MATERIAL EXAMINED

MEXICO. USNM 26141-2. "North America," HEID. (1). DISTRITO FEDERAL: Villa de Guadalupe, BLANCHARD (1); Mexico City, USNM 12728. GUANAJUATO : "Guanajuato, " USNM 11361, 12681. Hacienda Corones, border between GUANAJUATO and MEXICO, T-S 3746. JALISCO: Guadalajara, AMNH 3711-2; W. of Ocotlan, AMNH 19723. NAYARIT: La Labor, AMNH 19724. VERACRUZ: Mirador, USNM 31051.

Cope (1887, p. 80) has reported this species from Zacualtipan.

[Taylor and Smith (1939, p. 240) list another specimen from Corones, Guanajuato, and Taylor (1940, p. 455) reports one from Tulancingo, Hidalgo, and one from 15 km. west of Morelia, Michoacan.]

VARIATION

It is noteworthy that in the specimens examined only the females (three out of four) show a maximum of 19 rows of scales. In two of the three females the rows are 19 for only a very short distance, in the third the rows are 19 for a considerable distance. There is a marked difference between the sexes in the number of ventrals and in the proportionate length of the tail. A smaller sex difference is indicated in the caudal counts.

AFFINITIES

In two significant characters *dugesii* is different from all other forms of *Diadophis*. The scale rows are typically 17 throughout the body length, with a maximum of 19. The formula 17-19-17 may be typical of the female sex. The temporals are typically 1+2+2. In all other species of *Diadophis* they are typically 1+1+2.

The ring-neck snakes as a whole prefer a retiring, semi-burrowing life. Their small size, slender bodies, flattened heads, and habits attest this. It is natural to look for their ancestors among larger, more generalized forms fitted to the more severe competition above ground. It is a common observation that larger species as a rule have more scale rows than smaller species. This is especially true in the case of species that are apparently related. Amongst the ring-neck snakes, then, it is to be supposed that the most primitive species would have the largest number of scale rows. In this respect *dugesii* answers for the most primitive species. The flattening of the head in *Diadophis* must be regarded as a specialization, and the single temporal behind the first is best considered as a reduction in conformity with the narrowing space. The two posterior temporals in *dugesii* may fairly be taken as a primitive feature, beyond which all other forms of *Diadophis* have passed in their evolution.

For the two reasons here given, *dugesii* is regarded as the most primitive form of *Diadophis* now known. The rather large size, moderate number of ventrals and caudals, lack of extreme modification in any direction, and geographic position may be taken as in support of this theory.

Diadophis regalis laetus (Jan)

Arizona Ring-neck Snake

Fig. 14

1859. *Diadophis docilis?* BAIRD, Pac. R. R. Surv., vol. 10, Rept. pl. 32,* *fig. la-1 e*; U. S.-Mex. Bound. Surv., 1859, p. 22 (Tucson, Sonora).

1863. *Diadophis punctatus laetus* JAN, Arch. Zool. Anat. e Fisiol., p. 262, 265 (Type locality unknown, but probably Tucson, Arizona[t]. Type specimen originally in Heidelberg Museum); Prod. Icon. Gen. Ofidi, 1863, p. 52, 54; Elenco Sist. deg-1i Ofidi, 1863, p. 49; Icon. Gen. Ophid., liv. 15, 1866, pl. 6, *fig.* 6.

1883. *Diadophis regalis* GARMAN, S., Mem. Mus. Comp. Zool., vol. 8, no. 3, p. 73, 159 (San Luis Potosi).-STEJNEGER, Proc. U. S. Nat. Mus., vol. 25, 1902, p. 151.—STONE, Proc. Acad. Nat. Sci. Philadelphia, vol. 43, 1911, p. 231,—VAN DENBURGH, Proc. Calif. Acad. Sci., ser. 4, vol. 3, 1913, p. 415; Occ. Papers Calif. Acad. Sci., no. 10, vol. 2, 1922, p. 652, *883.—Liophis regalis* GUNTHER, Biol. Cent. Amer., 1893, Rept. and Batr., p. 108 (San Luis Potosi).

1888. *Diadophis texensis* GARMAN, Bull. Essex Inst., vol. 19, p. 127 (San Luis Potosi).

*Figures 2a-2e on plate 32 are also of this species but in this reference are not determined beyond the genus. They represent the specimen from Santa Magdalena.

[t] The locality of the second specimen listed as *D. docilis* by Baird in 1859 (U. S.-Mex. Bound. Surv., p. 22) is Tucson, Arizona, and the number is 2066. It was collected by Maj. Emory. This specimen does not appear to have been seen again by any American herpetologist and it is not now in the National Museum. But the specimen described by Jan as *Diadophis punctatus laetus may* very well have been this one, for this Tucson specimen is the only one of the kind that Jan describes that is now missing and that was obtained early enough to have been sent to Jan, from the collections of the National Museum, and it is unlikely that any collector, other than those on the United States Government surveys obtained specimens from the range of *laetus* at this early date. In line with this evidence is the fact that Baird figures two temporals in the second row in the Tucson specimen and Jan likewise shows two in *laetus.* This is the less common condition in the species. The one preocular figured by Baird is probably an error. These facts, together with the known liberal policy in distribution of specimens by the Smithsonian Institution (referred to in note under *docilis),* may be regarded as circumstantial evidence that the type locality of *D. r. laetus* is Tucson, Arizona.

In order to obtain further evidence as to the identity of the type of *laetus,* a request for information was sent to the director of the zoological museum at Heidelberg, Germany. Dr. Clara Hamburger, the custodian, sent for examination an old specimen, determined as *laetus* by Dr. Boettcher, which proved to belong to the Mexican species. This can not have been the type of *laetus* because it has 201 ventrals and 51 caudals. Jan's type had 222 ventrals and 77 caudals. Furthermore, this Heidelberg specimen was received from the Berlin Museum in 1863, too late to have been loaned to Jan from Heidelberg. The present location of the type of *laetus* is therefore still unknown.

1900. *Diadophis regalis regalis* COPE, Ann. Rep. U. S. Nat. Mus. (1898), fig. 155, p. 744.

1923. *Diadophis regalis arizonae* BLANCHARD, Occ. Papers Mus. Zool. Univ. Mich., no. 142, p. 2 (Type locality Sabino Canyon, Arizona; type specimen USNM 62568; G. Hofer, collector).—STEJNEGER AND BARBOUR, Check List, ed. 2, 1923, p. 84. —BLANCHARD, Papers Mich. Acad. Sci., Arts, Let., vol. 4 (1924), 1925, pt. 2, p. 34.—STEJNEGER AND BARBOUR, Check List, ed. 3, 1933, p. 91.—CAMPBELL, Occ. Papers Mus. Zool. Univ. Mich., no. 289, 1934, p. 9.—STEJNEGER AND BARBOUR, Check List, ed. 4, 1939, p. 100.

DESCRIPTION

Diagnosis.—This form, like *regalis*, is distinguished from all other ring-neck snakes by a high number of ventrals (females more than 220, males more than 205), and from *regalis* it is marked by a broad, light-colored hand behind the head.

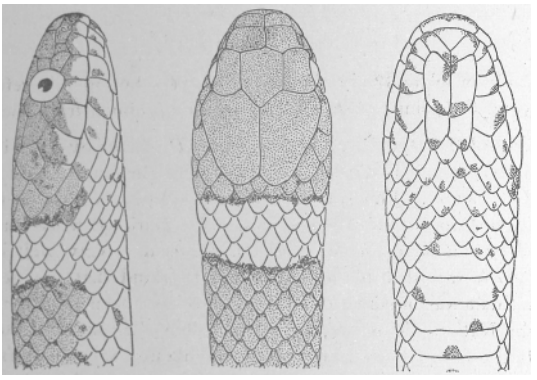


Fig. 14. *D. r. laetus, FNB,* Southern Arizona.

Scutellation.—The scutellation following is based upon 18 specimens: ventrals 210 to 239 (males 210-225, av. 216; females 227-239, av.223; caudals 62 to 72 (males 62-72, av. 69; females 62-67, av. 64); upper labials 7 (8 on one side in two instances); lower labials 8 (9 on one side of one specimen); preoculars 2; postoculars 2; temporals 1+1, less often 1+2; scale rows 17-15 (in one case 17-17).

Size and Form.—In size and proportions this form is like *regalis.* The tail varies from .156 to .212 of the total length (males .166-.212, av. .187; females .156-.177, av. .165). The largest specimen examined measured 749 mm. in total length and came from Fort Lowell, Arizona.

Coloration. — Color above in adults light bluish gray or darker, the dorsal scales more or less minutely flecked with black, and showing black at the base when the skin is stretched a little; and, in young individuals, dark slate color above; neck ring from 2 to 4 scales wide, narrowly bordered with black; neck ring and lower surfaces, and usually a portion of the first row of dorsal scales, yellowish, sometimes becoming brick red posteriorly, especially under the tail, and prominently marked on the posterior ends of the ventrals with black spots strongly convex anteriorly (the tail, however, is frequently unspotted below) ; head darker above than the body color, and, in light colored specimens, punctulated with black; labials and chin marked with black.

Dentition. The maxillary teeth in two specimens are 10 and 11 and 9 and 10. The last two are enlarged and separated from the others by a distinct space.

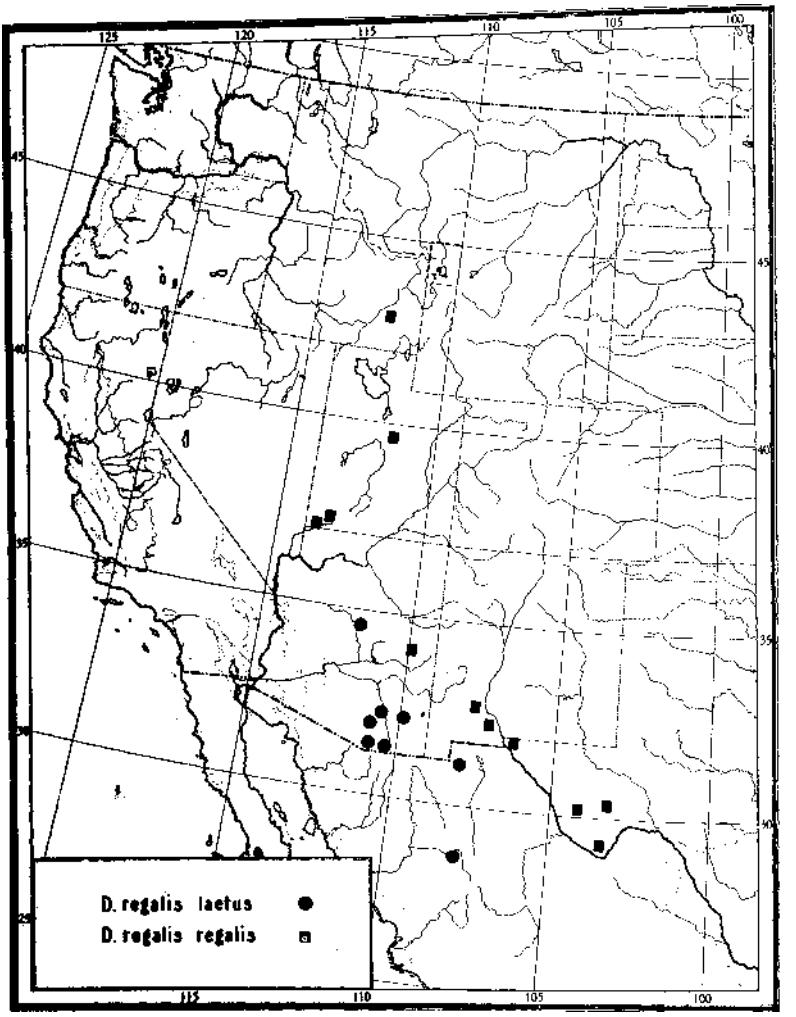
HABITAT AND HABITS

Specimens preserved with definite records appear all to have been taken in the mountains and mountain canyons. For Ramsey Canyon in the Huachuca Mountains Van Denburgh (1913, p. 415) records one taken "in a peach orchard, near the pine and oak belts . . . . just before dusk as it was entering a hole by the side of a fence post." This individual had eaten a large *Tantilla wilcoxi.*

Ditmars, writing of western ring-neck snakes in general (1907, p. 337) , says that they have a curious habit, when annoyed, of elevating and twisting the tail in corkscrew fashion, displaying both the dark ground color and the bright red of the underside and producing a peculiar effect. The tail is often reared two inches or more from the coil." This "peculiar characteristic," Professor Charles T. Vorhies of the University of Arizona writes, was shown "remarkably well" by two specimens from the Santa Rita Mountains which he kept for some time in captivity. An eight-inch specimen was found by Berry Campbell (1934, p. 9) in the stomach of a young Mexican screech owl.

DISTRIBUTION

Range. This form extends from central Arizona south and southeast [possibly] to San Luis Potosi (Map 3, p. 58) . Most of the specimens have been taken in southeastern Arizona.



Map 3. Geographic distribution of the ring-neck snakes of the *regalis* group.

MATERIAL EXAMINED

ARIZONA: AU (2); White River Canyon, USNM 10199. *Cochise* Co.—Fort Huachuca, USNM 21061; Huachuca Mts., CAS 48069, Ramsey Canyon, CAS 34756, mouth of Ramsey Canyon, SDS 14198. *Graham Co.*—Camp Grant, USNM 8019. *Pima Co.*—Fort Buchanan, ANSP 3465*; Fort Lowell, STANFORD 1729; Sabino Canyon, Santa

*Entered in the catalog of the U. S. National Museum, Jan. 30, 1861, as number 5026; later sent to the Philadelphia Academy.

Catalina Mts., USNM 62568 (Type of *Diadophis regalis arizonae),* 62569; Tucson, BYU 1185. *Yavapai* Co.—Fort Verde, AMNH 4202.

MEXICO. CHIHUAHUA: Basuriachi, Samachique, FMNH 11821; Casas Grande River, Dublan, UTAH 332. SAN LUIS POTOSI: "San Luis Potosi," MCZ 4523.

In addition to the localities represented by the list of specimens examined, three examples of *Diadophis* are recorded from Camp Mojave, Arizona, by Yarrow (1883, p. 96) . These specimens were not described and appear to have been lost so that their reference to this form must be with a degree of doubt. Other cases of the loss of undescribed specimens are Stone's records for Sycamore, Otero, and Baboquivari Canyons in the Baboquivari Mountains in Pima County, Arizona (1911, p. 231). There is no reasonable doubt, however, that Stone's specimens were typical of *laetus.* Professor Charles T. Vorhies reports two specimens with conspicuous neck rings taken in 1921 in the Santa Rita Mountains, about 40 miles south of Tucson. These specimens escaped while being kept alive.

The specimen from San Luis Potosi* seems to be typical of this form, but the locality it represents is so far outlying that confirmatory records are much to be desired. It may eventually be found that *laetus* has an extensive distribution in northern and western Mexico.

VARIATION AND AFFINITIES

The specimens of *laetus* have been taken within a very limited region (except for the one from San Luis Potosi) and are obviously too few to show the range of variation that must characterize the form. Certain features exhibited by the present material are, however, noteworthy in comparison with other forms of the genus. Its closest relationship is obviously with *regalis* from which it appears to be distinct only in the presence of the broad neck ring. Its next nearest relative is probably the *amabilis* complex, particularly the *modestus* section. With this it agrees

*Since this specimen (MCZ 4523) came from a locality so far removed from all others now known it will be desirable to put on record a fairly complete description of it. There are black bars across the upper and lower labials; the belly is sparsely marked with black spots of varying size and shape, but mostly convex anteriorly and straight across posteriorly; half of each scale of the lowermost row is light like the belly, anteriorly, but reduced, posteriorly, to about one-fourth light; the under side of the tail is unmarked, except for a black bar on the end of each caudal; there are a few black spots on the chin. It is a male, 433 mm. long, with scale rows 17-15, ventrals 210, caudals 70, upper labials 7-8, lower labials 8, temporals 1+1; neck ring two scales wide.

closely in the essentials of (1) high number of ventrals and caudals, (2) 7 upper labials, (3) a 17-15 scale formula, (4) temporals usually 1+1, and (5) the extension of the light ventral color onto the first row of dorsal scales. This last character is not invariable in either *laetus* or *modestus.* It differs from *modestus* particularly in its higher number of ventrals and caudals, and its broader neck ring.

To *dugesii* it is allied by its number of upper labials, its 17 rows of scales, the frequency of two temporals in the second row, and its relatively short tail. It differs from this form in the regularity of 15 rows of scales on the posterior portion of the body, the higher number of ventrals and caudals, the usually single posterior temporal, and the common presence of the ventral color on the lower row of dorsal scales.

Its differences from *docilis* are about as great as its differences from *dugesii.* With the other eastern ring-neck snakes it has little, if any, more than generic resemblances.

D. r. laetus is thus most closely allied to the forms geographically nearest to it.

Diadophis regalis regalis (Baird and Girard)

Regal Ring-neck Snake

Fig. 15

1853. *Diadophis regalis* BAIRD AND GIRARD, Cat. N. Amer. Rept., p. 115 (Type locality Sonora,* Mexico. Type specimen USNM 2062.); *idem,* p. 161.—BAIRD, Pac. R. R. Surv., vol. 10, Rept. 1859, pl. 33, fig. 86; U. S.-Mex. Bound Surv., 1859, p. 22.—COPE, Proc. Acad. Nat. Sci. Philadelphia, 1866, p. 310; Bull. U. S. Nat. Mus., no. 1, 1875, p. 38, 91.—COUES, Geog. Geol. Expl. Surv. W. 100th Merid., vol. 5, 1875, p. 623.—YARROW, Bull. U. S. Nat. Mus., no. 24, 1882, p. 15, 97.—COPE, Proc. Acad. Nat. Sci. Philadelphia, 1883, p. 12.—GARMAN, Mem. Mus. Comp. Zool., vol. 8, 1883, no. 3, p. 73, 159 (part).—--YARROW, Smiths. Misc. Coll., no. 5 1 7 , 1883, p. 15.—COCKERELL,

*The type of *D. regalis* was collected on the United States and Mexican Boundary Survey and, since it is labeled "Sonora, Mexico," it must have come from what is now southern Arizona or northern Sonora or extreme southwestern New Mexico. If there is geographic segregation of the ringed and rimless phases, as is here supposed, this specimen must have come from the eastern part of this area. It was collected by J. H. Clark and received at the Smithsonian Institution from Col. J. D. Graham. [See Stejneger, 1940, p. 204.]

Amer. Nat., vol. 30, 1896, p. 326.—BROWN, Proc. Acad. Nat. Sci. Philadelphia, 1901, p. 70.—BAILEY, N. Amer. Fauna, no. 25, 1905, p. 28, 35, 45.--STRECKER, Baylor Univ. Bull., vol. 12, 1909, no. 1, p. 14.-STEJNEGER AND BARBOUR, Check List, 1917, p. 76.--WOODBURY, Copeia, no. 166, 1928, p. 19.

[?] 1859. *Diadophis docilis** BAIRD, Pac. R. R. Surv., vol. 10, Whipple-Ives Surv., no. 4, p. 43.

1875. *Diadophis pulchellus* YARROW, Geog. Geol. Expl. W. 100th Merid., vol. 5, p. 538.

1882. *Diadophis punctatus pulchellus* YARROW, Bull. U. S. Nat. Mus., no. 24, p. 15 (Utah).

1886. *Diadophis punctatus regalis* DUMERIL AND BOCOURT, Miss. Sci. Mex., pt. 3, p. 624.—COPE, Bull. U. S. Nat. Mus., no. 32, 1887, p. 80.—*Diadophis regalis regalis* COPE, Proc. U. S. Nat. Mus., vol. 14, 1892, p. 615; Amer. Nat., 1896, p. 1014; Ann. Rep. U. S. Nat. Mus. (1898), 1900, p. 744 (part).—BLANCHARD, Occ. Papers Mus. Zool. Univ. Mich., no. *142*, 1923, p. 1.-STEJNEGER AND BARBOUR, Check List, ed. 2, 1923, p. 84.-BLANCHARD, Papers Mich. Acad. Sci., Arts, Let., vol. 4 (1924), 1925, pt. 2, p. 35.—TANNER, Copeia, no. 163, 1927, p. 56.--WOODBURY, Bull. Univ. Utah, vol. 21, 1931, no. 5, p. 68.—STEJNEGER AND BARBOUR, Check List, ed. 3, 1933, p. 91.-TANNER, Utah Acad. Sci. Arts, Let., 1935, p. 268.-STEJNEGER AND BARBOUR, Check List, ed. 4, 1939, p. 99.

1888. *Diadophis texensis* GARMAN, Bull. Essex Inst., vol. 19, p. 127.

1900. *Diadophis amabilis docilis* COPE, Ann. Rep. U. S. Nat. Mus. (1898), *fig.* 158, p. 748 [part].

1903. *Diadophis amabilis* BROWN, Proc. Acad. Nat. Sci. Philadelphia, p. 550.-VAN DENBURGH, Occ. Papers Calif. Acad. Sci., no. 10, 1922, vol. 2, p. 650, pl. 61.

1907. *Diadophis punctatus* DITMARS, Reptile Book, p. 338 (part).

*This specimen (USNM 2078) is recorded as collected by Dr. Kennedy, the naturalist on that portion of the Whipple-Ives expedition that went from San Antonio to El Paso, then north to Albuquerque. Presumably, then, it was collected somewhere on a line from El Paso about due east to the Pecos River. This specimen has a neck ring three scales wide and is, therefore, contrary to what is to be expected in this region. If the locality with this specimen is not in error, it is evidence so far as it goes, that the ringed and ringless phases are not geographically separated. Since, however, this is the only evidence of this kind, the author feels it is best for the present to question the locality of this specimen.

[Dr. Blanchard's notes state that this specimen is a male, scale rows 17-15, ventrals 209+, caudals 57, upper labials 7, lower labials 8, temporals 1+1. Since no measurements are recorded it is probably not well preserved. On the basis of the above data, and the presence of the neck ring, it appears possible that this specimen represents *D. p. docilis. See* Table II, p. 20, and the description of *docilis.*]

DESCRIPTION

Diagnosis.— This form is distinguished from *laetus* by the absence, or great reduction of the neck ring, and perhaps in the light coloration of the top of the head in the adult. From other forms of *Diadophis* it is distinguished by the high number of ventrals, 204 or more in specimens examined.

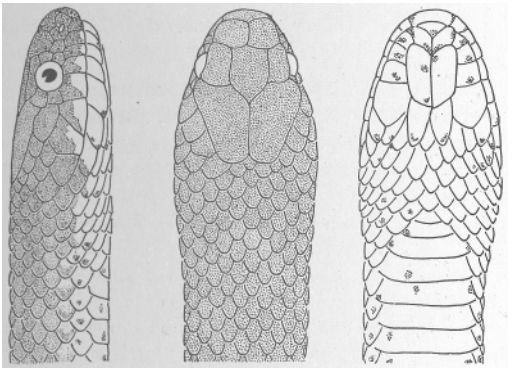


Fig. 15. *D. r. regalis,* MZUM 61626, San Pete County, Utah.

Scutellation.— The scutellation based upon the 21 specimens examined is as follows: ventrals 204 to 236 (males 204-224, av. 216; females 224-236, av. 230); caudals 53 to 79 (males 57-79, av. 65; females 53-66, av. 60) ; upper labials 7 (but in two specimens 8 on each side); lower labials 8 (in two specimens 9); preoculars 2; postoculars 2; temporals 1+1 (infrequently 1+2); scale rows 17-15 (in one case 17-17).

Form and Size.—The body is unusually long for its diameter, a little wider at the temples, scarcely or not at all narrower at the neck, and tapers gradually towards its posterior end, and quickly on the tail. The tail varies from .107 to .205 of the total length (males .180-.204, av. .190; females .107-.167, av. .154). The largest specimen examined, a female from El Paso County, Texas, measured 681 mm.

Coloration.—The general coloration above, judging from preserved specimens, is light bluish gray in adults; in the young it is darker, to brown or blackish brown. The dorsal scales are finely marked with black, and, when the skin is stretched a little, they show black at their bases. The neck ring is entirely absent in ten specimens, and is narrow

and indistinct or broadly interrupted in four. In one specimen which seems to have been taken within the range of this form the ring is present and three scales wide (See footnote on page 61.) . The head is but little darker than the general dorsal surface; the upper and lower labials and chin are marked with black. The lower surface is yellow, sometimes becoming brick red posteriorly, especially on the tail, and prominently marked on the posterior ends of the ventrals with black spots strongly convex anteriorly. The light ventral coloration usually extends onto the first row of dorsal scales.

HABITAT AND HABITS

The habits of this form are presumably similar to those of *laetus,* concerning which there are more records. In Washington County, Utah, it is known to the local people, according to Woodbury (1928, p. 19), as "the thimble snake from a peculiar habit which it possesses of curling its tail with the bright colored underparts outside. The black dots on the border give it a faint resemblance to a thimble. It appears to be very shy in its habits and is seldom seen."

The specimen from the Chisos Mountains, Texas, was found at an elevation of 5000 feet. The one collected at Box Canyon near Freedom, Utah, was taken from the canyon walls or from ridges above those walls

[Wilmer W. Tanner in two recent papers has added to our knowledge of this snake in Utah. He reports (1940, p. 141) a "large specimen" found in Zion National Park swallowing a small *Pituophis c. deserticola.* He gives scale counts of eight specimens (1941, p. 17-18), records a maximum length of 726 mm. in a female from Zion Canyon National Park, and with reference to general distribution and habitat comments as follows: "From the distribution records now available it becomes quite evident that this snake should be found throughout Utah, wherever a suitable habitat can be found. Records would indicate that this species inhabits the Oak, Juniper, Pinyon-Pine Belts of our foot hills, 5000 ft., and up to the Aspen-Fir Belt at an elevation of 7000 ft. In Southern Utah it has been taken as low as 4045 ft. Because of its secretive habits few specimens are seen or collected." He mentions one found under a pine log in Pine Valley, Washington County, and four others in the same area under rocks in the "Oak brush." The large female (726 mm.) from Zion Canyon was collected in May and contained five eggs averaging 19.24 mm. long and 7.2 mm. wide, but there was no indication of developing embryos.]

DISTRIBUTION

Range. D. r. regalis appears to be distributed from southeastern Idaho south through Utah to its extreme southwest, thence across [northeastern Arizona and] New Mexico into Texas west of the Pecos River (Map 3, p. 58).

MATERIAL EXAMINED

ARIZONA: Camp Apache [Fort Apache, Navajo Co. ?], USNM 8427.

IDAHO: *Bannock* Co.—Pocatello, KU 9526.

NEW MEXICO: *Dona Ana* Co.—Mesilla Valley, USNM 22378. *Sierra Co.*—Lake Valley, ANSP 10786.

TEXAS: Between Pecos River and Rio Grande, USNM 2078 [possibly *D. p. docilis]. Brewster* Co.—Chisos Mts., USNM 32780. *El Paso* Co.--Eagle Spring, USNM 2064. *Jeff Davis* Co.—Davis Mts., ANSP 17024; Fort Davis, USNM 10628. *Pecos* Co.—Fort Stockton, USNM 5178.

UTAH: USNM 8599. *San Pete* Co.—Box Canyon, near Freedom, MZUM 61626. *Washington Co.—St. George,* PACK (1); Springdale, UTAH 66; Zion Nat. Park, 4300 feet, UTAH 804.

MEXICO; SONORA: USNM 2062 (Type).

[Tanner (1940, p. 141-142; 1941, p. 17) reports this subspecies from the following additional localities: IDAHO: *Franklin* Co.—Preston; UTAH : *Juab* Co.—Deep Creek Mts. and Birch Creek Canyon; *Piute Co.* Circleville; *Utah* Co.—Pole Canyon near Cedar Fort; *Washington* Co.—Pine Valley.]

A specimen of this form was reported by Cope (1883, p. 12) as collected by Professor Frank Snow at Socorro, New Mexico. Cope identified this specimen as *regalis,* and remarked that it is "the first time this rare species has been found within the limits of the United States." He further remarked that it "differs from the typical one in having eight superior labials." Had it possessed a neck ring, Cope wonld surely have mentioned it, but, in that case, would most likely have called it *docilis*. The specimen can not now be found, hut from the above, it seems safe to regard it as a typical *regalis.*

That *regalis* is the type in Utah is confirmed by two recent specimens from widely separated localities in that state, that the writer has had opportunity to examine: the specimens from St. George, Washington County, and Freedom, San Pete County. The St. George specimen, collected by H. J. Pack, is a juvenile with incomplete tail. It is uniformly nearly black above, scarcely darker on the head; there are many small, scattered spots on the belly; chin and lower labials are spotted; only the first five upper labials show light color and these on their anteroventral portions; there is slight encroachment of the ventral color on the first

row of dorsal scales, even at the posterior end of the body. There is no trace of neck ring. The specimen from Freedom, San Pete County, is a large adult, in appearance typical of *regalis,* but having nine lower labials on each side, 17 rows of scales throughout the body length, and two temporals in the second row.

VARIATION

More specimens from all parts of the range here ascribed to *regalis* are urgently needed. At present we can only point out that the evidence favors the view that in this region there occurs an essentially ringless race of *Diadophis,* allied in most if not in all other respects with the Arizonan form.

Four specimens, assigned to *regalis,* have partially developed neck rings. The specimen from Fort Stockton, Texas, has an indistinct ring one scale wide; one from Sierra County, New Mexico, has an indistinct ring one-half scale wide; the one from Camp Apache, Arizona, has a ring two scales wide, that is indistinct in the middle; and Dr. Yarrow's specimen from "Utah" [USNM 8599] has a ring that is interrupted across five scales.

The specimen from Bannock County, Idaho, has each scale of the first row black-tipped, and on each scale of the second row, on the anterior third or fourth of the body, there is a small spot of yellow. The belly is well speckled with small black spots, and the chin is spotted. The underside of the tail was red in life.

AFFINITIES

The intimate relationship between *regalis* and *laetus* is very obvious. In fact the only distinction discovered by the writer is the absence of the neck ring in the former. The argument that this may be a primitive character requiring that we regard *regalis* as the most primitive form of *Diadophis* will hardly bear weight in the face of its excessive number of ventral plates and its less primitive condition in scale rows and temporals than *dugesii.*

Regalis must, apparently, be regarded as a differentiation of *laetus,* and its relationships to other forms of *Diadophis* must be sought through that form.

The close approach of *docilis* to the range of *regalis* brings up the question of intergradation. The specimens at hand show but little in favor of this possibility, and the present author's interpretation of affinities within the genus does not allow for any direct relationship between *regalis* and *docilis.* if such intergradation should be proved it would be necessary to attribute it to hybridization, or to alter somewhat the present view of relationships.

Diadophis punctatus docilis (Baird and Girard)

Texan Ring-neck Snake

1853. *Diadophis docilis* BAIRD AND GIRARD, Cat. N. Amer. Rept., p. 114 (Type locality between Rio San Pedro or Devil's River and Comanche Spring, Texas. Type specimen originally USNM 2074, but apparently sent to the Milan Museum about 1860; collected by J. H. Clark).—BAIRD, Pac. R. R. Surv., vol. 10, Rept., pl. 33, fig. 84; U. S.-Mex. Bound. Surv., 1859, p. 22 (part), pl. 21, fig. 3 (?).—COUES, Geog. Geol. Explor. Surv. W. 100th Merid., vol. 5, 1875, p. 623.

1863. *Diadophis punctatus docilis* JAN, Arch. Zool. Anat. Fisiol., p. 262, 264; Prod. Icon. Gen. Ofidi, 1863, p. 52, 54; Elenco Sist. degli Ofidi, 1863, p. 49; Icon. Gen. Ophid., liv. 15, 1866, pl. 6, fig. 2.-GARMAN, S., Mem. Mus. Comp.

*The type locality given by Baird and Girard in the original description is "Rio San Pedro of Rio Grande or Devil's River." Only one specimen is cited, so it is without doubt the same as USNM 2074 from "Devil's River, Texas," listed the first of three which are referred to *D. docilis* by Baird in 1859 (U. S.-Mex. Bound. Surv., p. 22). The other two in this list are USNM 2066, Tucson, Sonora, A. Schott, and 2078, Pecos to Rio Grande, Dr. C. B. R. Kennerly. Under the same date, 1859, in the plates without text in the Pacific Railroad Survey, Baird figures a *Diadophis docilis* from "San Pedro, Comanche Spring." In the introduction to these figures, Baird writes, "the figures have, as far as possible, been taken from the type specimens of the species, especially those described in the catalogue of serpents in the museum of the Smithsonian Institution (1853), to which the page column refers." No numbers are given for these specimens. But from the fact that Comanche Spring is only about 150 miles, by way of the route traveled, northwest of Devil's River and on the course taken by the party that collected the type of *docilis* (see map of the Territory of the United States from the Mississippi to the Pacific Ocean in the *Reports of Explorations and Surveys from the Mississippi River to the Pacific Ocean,* 1861, vol. 11), and since no specimen with this datum is mentioned by Baird in the catalog of serpents (1853), it is probably fair to assume that Baird here figured the type of *Diadophis docilis,* and that "San Pedro, Comanche Spring" is a corrected form of the locality.

This specimen was not entered in the accession book of the Smithsonian Institution until March 5, 1858. Here, in Girard's handwriting, the locality reads "bet. S. Pedro & Comanche Spr." This specimen is not now in the U. S. National Museum and no indication that it was seen by any American investigator appears subsequent to 1859. However, in 1863 Jan cites a specimen of *Diadophis punctatus docilis* from "S. Pedro to Comanche Springs, Texas," as in the Milan Museum, and refers to it as "the specimen received from Washington and described by Baird and Girard as *D. docilis"* (Prod. Icon. Gen. Ofidi, p. 541.

It is not surprising that a type specimen should have been sent abroad, for about 1860 the Smithsonian Institution established the policy of *giving* out types and duplicates as widely as possible. This policy is stated in the Report of the Secretary for 1860, p. 44-47. A policy of restriction applied only to collections that had not been studied by experts and that might, therefore, contain undescribed species.

Inquiry by letter has brought the reply, under the date of February 23, 1927, from Dr. Guiseppe Scortecci that the type of *docilis* is not now in the Museo Civico di Storia Naturale at Milano.

The general tendency heretofore has been to ally this specimen with the form inhabiting the region from Texas to Arizona *(regalis);* in fact, the writer has heretofore so allied it. But in the light of a thorough-going study of this whole situation, and new material recently made available, it appears that another subspecies must be recognized. Baird and Girard's description and Jan's furnish together a rather satisfactory account of this important type.

Zool., vo . 8, 1883, no. 3, p. 72, 158.-DUMERIL AND BOCOURT, Miss. Sci. Mex., pt. 3, 1886, p. 619.—*Diadophis amabilis docilis* COPE, Proc. U. S. Nat. Mus., vol. 14, 1892, p. 616; Amer. Nat., vol. 30, 1896, p. 1009; Ann. Rep. U. S. Nat. Mus. (1898), 1900, p. 748 (part).

DESCRIPTION

Diagnosis. In general similar to *D. p. arnyi* but larger and with a distinctly higher number of ventrals and higher average number of caudals; dorsal scales usually in 15 rows.

Scutellation.— On the basis of 11 specimens (including published data on the type) the scutellation is as follows: ventrals 175-208 (6 males 175-193, av. 186; 5 females 191-208, av. 200) ; caudals 41-58 (6 males 52-58, av. 55; 5 females 41-50, av. 47) ; upper labials 7 (one has 8 on one side) ; lower labials 8 (one has 9 on one side) ; preoculars 2 (in three specimens 1) ; postoculars 2 (in one specimen 1) ; temporals 1+1; dorsal scale rows 15 in six specimens, 17-15 in three, 15-13 in one, and an apparent irregularity, 16-17-15, in one.

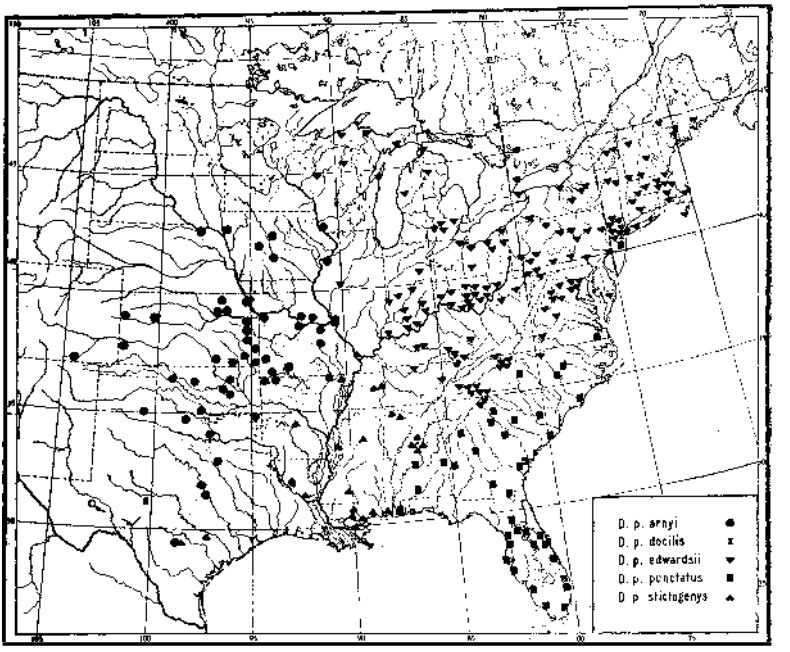
Form and Size. In bodily proportions and size *docilis* shows tendencies toward the more western representatives of the genus. The tail varies from .135 to .189 of the total length (6 males .179-.189, av. .185; 5 females .135-.157, av. .148) . The largest specimen examined, a female (BAYLOR 6135) from Chrystoval, Tom Greene County, Texas, measured 422 mm. in total length.

Coloration. The alcoholic specimens examined are dark slate-gray to black above, the dorsal color extending down over all dorsal scale rows, even anteriorly. The top and sides of the head are black, with the exception of the lower edges of the labials, and the dark pigmentation extends around the corner of the mouth as in *arnyi.* The neck ring is 2-3 scales wide and not interrupted middorsally. The color of the neck ring and ventral surface is faded but in one specimen there is a strong trace of red on the underside of the tail. There is a short black bar on the posterior lateral angle of each ventral and caudal, and the ventral surface is irregularly marked with distinct black spots which become smaller on the gulars and chin.

DISTRIBUTION

Range. At present known only from western Texas (probably from the southern end of the Staked Plain south to Devil's River) . The only

definite locality from which recent specimens are available is Chrystoval, Tom Greene County (Map 4) . See footnote on type specimen and type locality, page 66.



Map 4. Geographic distribution of the ring-neck snakes of the *punctatus* group. Small arrows in western Texas indicate the location of Devil's River ("Rio San Pedro of Rio Grande") and Comanche Spring (near Fort Stockton), points of interest in connection with the type specimen of *Diadophis docilis* Baird and Girard.

MATERIAL EXAMINED

TEXAS: Llano Estacado, ANSP 3469, collected by Captain Pope* (examined by F.N.B.) . *Tom Greene Co*.—Chrystoval, BAYLOR 5252-5, 5644, 6254 (examined by F.N.B.); BAYLOR 6135-6, 6588 (examined by H.K.G.).

VARIATION

Variation in the more important characters has been given above in the descriptive section. The specimen collected by Capt. Pope on the southern end of the Llano Estacado (ANSP 3469) , here confidently iden-

*[For an account, with map, of Capt. Pope's expedition of 1854, see Crimmins, M. L., "Captain John Pope's Route to the Pacific," *Military Engineer,* March-April, 1931.]

tified with this subspecies, should be described in essential detail. The ventral color does not extend onto the first dorsal scales except for a little at the extreme anterior end, a degree of extension that has no signficant bearing on a relationship with *regalis.* The neck ring is not interrupted. The spots below are in an irregular median line, significant of the present form and not of *regalis.* The chin has a few dark flecks. The snake is a female with the following scutellation: scale rows 15-15; ventrals 191; caudals 50; upper labials 7; lower labials 8; temporals 1+1. Total length 178 mm.

AFFINITIES

D. p. docilis is obviously most closely allied to *arnyi* and may represent a population annectant between *arnyi* and the Mexican species, *dugesii.*

Diadophis punctatus arnyi (Kennicott)

Ozark Ring-neck Snake; Arny's Ring-neck Snake

Fig. 16

1859. *Diadophis arnyi* KENNICOTT, Proc. Acad. Nat. Sci. Philadelphia, p. 99 (Type locality Hyatt, Anderson County, Kansas. Type specimen USNM 1968; collected by Samuel Arny) .-COPE, Bull. U. S. Nat. Mus., no. 1, 1875, p. 38.-JORDAN, Man Vert., 1876, p. 180.-CRAGIN, Trans. Kans. Acad. Sci., vol. 7, 1881, p. 120.-YARROW, Bull. U. S. Nat. Mus., no. 24, 1882, p. 15, 90 (part). -DAVIS AND RICE, Bull. Ill. St. Lab. Nat. Hist., no. 5, 1883, p. 35; Bull. Chicago Acad. Sci., vol. 1, 1883, no. 3, p. 29.-HURTER, Cat. Rept. Batr. Missouri, 1883, p. 5.-YARROW, Smiths. Misc. Coll., no. 517, 1883, p. 15.-OSBORN, Cat. Anim. Iowa, Iowa Agr. Col., 1892, p. 9.-STONE, Proc. Acad. Nat. Sci. Philadelphia, 1903, p. 541.-STEJNEGER AND BARBOUR, Check List, 1917, p. 76. -RUTHVEN, Occ. Papers Mus. Zool., Univ. Mich., no. 66, 1919, p. 2.-DICE, Ecology, vol. 4, 1923, p. 52.-PRATT, Man. Vert. Anim. U. S., 1923, p. 214.-STRECKER, Baylor Univ. Bull., vol. 27, 1924, no. 3, p. 42.

1860. *Diadophis occipitalis* COPE, Proc. Acad. Nat. Sci. Philadelphia, p. 250.

1863. *Diadophis punctatus arnyi* JAN, Prod. Icon. Gen. Ofidi, p. 52, 55; Elenco Sist. degli Ofidi, 1863, p. 49; Arch. Zool. Anat. Fisiol., 1863, p. 262, 265; Icon. Gen. Ophid., liv. 15, 1866, pl. 6, fig. 5.-GARMAN, S., Mem. Mus. Comp. Zool., vol.8, no. 3, 1883, p. 72, 1 58.-DUMERIL AND BOCOURT, Miss. Sci. Mex., pt. 3, 1886, p. 622.-BLANCHARD, Occ. Papers Mus. Zool., Univ. Mich., no. 117, 1922, p. 9.-STEJNEGER AND BARBOUR, Check List, ed. 2, 1923, p. 83. -BLANCHARD, Papers Mich. Acad. Sci. Arts, Let., vol. 4 (1924), 1925, pt. 2, p. 34.-FORCE, Copeia, no. 141, 1925, p. 27; Proc. Okla. Acad. Sci., 1926, p. 84.-ORTENBURGER, Copeia, no. 156, 1926, p. 145.-GUTHRIE, Iowa St. Col., Agr. Exp. Sta. Bull. 239, 1926, p. 171.-ORTENBURGER, Proc. Okla.

Acad. Sci., 1926, p. 96; *ibid.*, p. 208, *fig.* 20.-BURT, Occ. Papers Mus. Zool., Univ. Mich., no. 189, 1927, p. 4.-STRECKER AND WILLIAMS, Contrib. Baylor Univ. Mus., no. 12, 1927, p. 14 .-POPE AND DICKINSON, Bull. Milwaukee Publ. Mus., vol. 8, 1928, no. 1, p. 49, *fig.* 11.-GLOYD, Trans. Kans. Acad. Sci., vol. 31, 1928, p. 121, 137.-VAN CLEAVE, Trans. Ill. St. Acad. Sci., vol. 20, 1928, p. 134, table Z.-TAYLOR, Univ. Kans. Sci. Bull., vol. 19, 1929, no. 5, p. 54.-ORTENBURGER, Copeia, no. 170, 1929, p. 27.-JORDAN, Man. Vert . Anim., ed. 13, 1929, p. 236.-FORCE, Copeia, 1930, no. 2, p. 30.-ORTENBURGER, Univ. Okla. Biol. Surv., vol. 2, 1930, no. 4, p. 182, 219.-GLOYD, Papers Mich. Acad. Sci. Arts, Let., vol. 15 (1931), 1932, p. 402.-STEJNEGER AND BARBOUR, Check List, ed. 3, 1933, p. 90.-BRENNAN, Trans. Kans. Acad. Sci., vol. 37, 1934, p. 191.-BREUKELMAN AND DOWNS, Trans. Kans. Acad. Sci., vol. 39, 1936, p. 268.-HIBBARD, Copeia, 1937, no. 1, p. 74.-TROWBRIDGE, Amer. Midl . Nat., vol. 18, 1937, no. 2, p. 295.-STEJNEGER AND BARBOUR, Check List, ed. 4, 1939, p. 99.-BRECKENRIDGE, Copeia, 1942, no. 2, p. 128.

1878. *Diadophis punctatus* MOSLEY, Trans. Kans. Acad. Sci., vol. 6, p. 35.-CRAGIN, Trans. Kans. Acad. Sci., vol. 7, 1881, p. 120.-GARMAN, H., Bull. Ill. St. Lab. Nat. Hist., vol. 3, 1892, p. 301.-BRANSON, Kans. Univ. Sci. Bull., vol. 2, 1904, no. 13, p. 407, *fig.* 28.-LINSDALE, Copeia, no. 164, 1927, p. 78.

1881. *Diadophis punctatus docilis* CRAGIN, Trans. Kans. Acad. Sci., vol. 7, p. 120. -TAYLOR, Ann. Rep. Nebr. St. Bd. Agr. (1891), 1892, p. 345.

1881. *Diadophis punctatus amabilis* CRAGIN, Trans. Kans. Acad. Sci., vol. 7, p. 120. -DAVIS AND RICE, Bull. Chicago Acad. Sci., vol. 1, 1883, no. 3, p. 29; Bull. Ill. St. Lab. Nat. Hist., no. 5, 1883, p. 35.

1900. *Diadophis regalis arnyi* COPE, Ann. Rep. U. S. Nat. Mus. (1898), p. 745 (part) .-HURTER AND STRECKER, Trans. Acad. Sci. St. Louis, vol. 18, 1909, no. 2, p. 25.-HURTER, Trans. Acad. Sci. St. Louis, vol. 20, 1911, no. 5, p. 188.

1904. *Diadophis regalis* BRANSON, Kans. Univ. Sci. Bull., vol. 2, no. 13, p. 407.* -ELLIS AND HENDERSON, Univ. Colo. Studies, vol. 10, 1913, no. 2, p. 101, pl. 4, fig. 21.-STRECKER, Bull. Sci. Soc. San Antonio, no. 4, 1922, p. 22 (?).-OVER, S. Dak. Geol. Nat. Hist. Surv., Bull. 12, 1923, p. 26.

1917. *Diadophis amabilis* CROSS, Okla. Geol. Surv. Cir. no. 6, p. 34.-VAN WAGENEN, Copeia, no. 43, 1917, p. 43.

DESCRIPTION

Diagnosis. Characteristic of *D. p. arnyi* are the extension of the dark color of the head around or across the angle of the jaw and slightly forward on the lower jaw, scattered spots on the belly, usually 17 rows of dorsal scales, 7 upper labials, and a moderate number of ventrals (142-185) . There is little difficulty in distinguishing *arnyi* from any other

*[Dr. E. H. Taylor has told me that the specimens on which this reference is based are not *Diadophis.]*

members of the genus except *docilis* and *stictogenys.* Here the best distinction is on the number of ventrals. In *docilis,* considering the sexes separately, the number of ventrals is distinctly higher (Table II, p.20). In *stictogenys,* except in the region of intergradation, males have fewer than 145 ventrals and females fewer than 150, while in *arnyi* males have more than 145 and females more than 150.

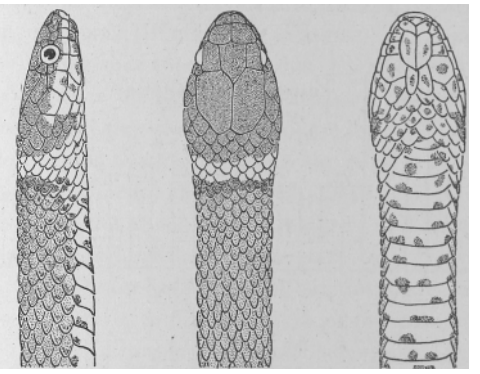


Fig. 16. *D. p. arnyi,* UOMZ 534, Ardmore, Carter County, Oklahoma.

Scutellation.— Examination of over 800 specimens reveals the following scutellation: ventrals 142 to 185 (males 142-169, av. 156; females 151-185, av. 168) ; caudals 30 to 57 (males 37-57, av. 46; females 30-50, av. 41); upper labials 7, occasionally 8, rarely 6; lower labials 8, occasionally 7, rarely 6; preoculars 2, rarely 1, in two cases 3 on each side; postoculars 2, rarely 1; temporals usually 1+1, rarely 1+2; posterior pair of chin shields parallel and generally a little shorter and narrower than the anterior pair; dorsal scale rows usually 17-15, but sometimes 17-17, 15-17-15, or 15-15. A specimen from Clifton, Texas, has the unique formula (for this subspecies) of 17-19-17.

Length.— In body form *arnyi* is on the whole rather shorter and more slender than *edwardsii.* The tail varies from .125 to .220 of the total length (males .153-.220, av. .188; females .125-.196, av. .155). The largest specimen, among 835 examined, measured 361 mm. in length (about 14 inches) and was a female from Tulsa, Oklahoma; the smallest specimen, newly hatched, measured 98 mm. For a summary of total length in this subspecies see Fig. 17.

In order to show the type of variation to be found in a large series from a limited area, the measurements of specimens from the state of Oklahoma are plotted separately from those of specimens from all other

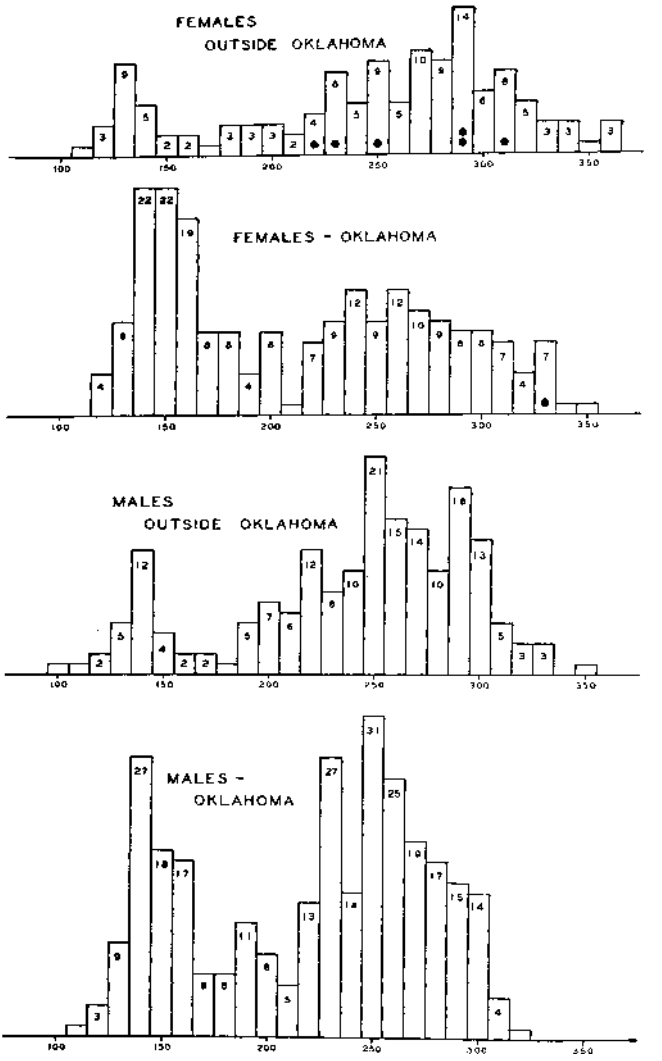


Fig. 17. Distribution by size (total length to nearest 10 mm.) and sex of 808 specimens of *D. p. arnyi.* Solid spots in uppermost diagram indicate females with eggs.

localities. It will be evident from a comparison of the graph for Oklahoma with that for the remainder of the range of *arnyi,* that, sex by sex, the length variation in Oklahoma presents an essentially true picture of the variation in length throughout the range of the subspecies.

Each graph is divisible roughly into a smaller group of shorter individuals and a larger group of longer ones, with a separation between the two groups somewhere in the vicinity of 210 mm. in total length. That the females longer than 210 mm. are adults (i.e., sexually mature) is probable from the fact that specimens that have embryos or have been observed to lay eggs are well distributed through this group, as indicated on the diagram. And that the males longer than 210 mm. are likewise sexually mature is a fair assumption from the close correspondence of the curve for males with that for the females. However, additional evidence is available that the males reach sexual maturity at a length of about 210 mm. This evidence is furnished by the anal ridges (Blanchard, 1931, p. 95 *et seq.)* . A diagram showing the relation between presence and absence of these structures and total length of the snake in this subspecies (Fig. 18) reveals that, although these anal ridges may be distinguishable on specimens of all sizes, even the smallest, there is a marked disproportion above about 210 mm. between individuals possessing them and those lacking them. Even though these structures seem to be less definitely correlated with sexual maturity in this subspecies than in *edwardsii (Blanchard, loc. cit.)* it can hardly be doubted that they confirm the conclusion derived from a comparison of the lengths of both sexes of *arnyi;* i. e., that the males, as well as the females, become sexually mature about the time they reach a length of 210 mm., or a little more.

Color and Markings. The general color above, a dark slate-gray or brownish-slate to black, extends over all the dorsal scales. The top of the head is a little darker. Around the angle of the mouth the dark color of the head extends somewhat ventrally over the last labials and forward on the gular scales. The neck ring is ordinarily 1 to 2 scales in width (rarely as narrow as one-half scale or as wide as three) ,and is edged behind with black. It is completely interrupted in the median dorsal line in about 14 per cent of all specimens and partly interrupted in about as many more. On the posterior lateral angle of each ventral and caudal is a black bar. These bars are often poorly developed on the forward portion of the body and are usually most prominent on the tail. The rest of the lower surfaces are variously spotted with black, frequently with the tail excepted, and rarely the chin. The spots on the ventral scales may be large or small, may be scattered without evident arrangement, or may

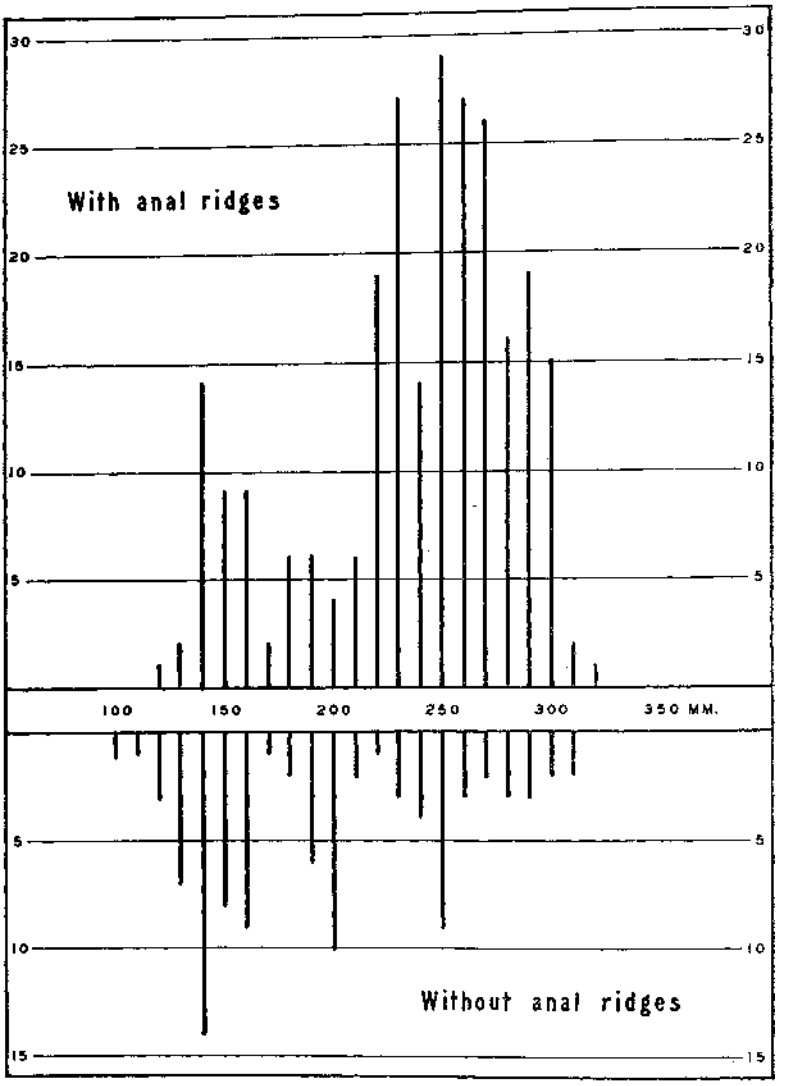


Fig. 18. Correlation between development of anal ridges and total length of males of *D. p. arnyi* in Oklahoma. Specimens possessing anal ridges are plotted above, those lacking them below. The figures in a horizontal line represent total lengths in millimeters, the number of specimens in each size group is indicated vertically.

be ranged in two fairly regular rows throughout the length of the body, or, not infrequently, they tend to be aggregated in a more or less irregular median line. Rarely the belly is wholly immaculate. The dark color of the head stops abruptly on the upper edges of the upper labials, and the remainder of these plates, as well as the lower labials, is usually more or less spotted like the belly. The neck ring and belly are orange, the throat pale yellow, and the lower surface of the tail red. The latter color sometimes extends forward onto the posterior part of the abdomen.

Living specimens from Okmulgee County, Oklahoma, have the underside of the body bright Ochraceous-Orange or Capucine Yellow, paler at the anterior end, and often becoming suffused with Brazil Red near the posterior end. The tail is Brazil Red below. The neck ring is the color of the belly or a little darker. The upper surface is Chaetura Drab, the head a little darker.

Dentition.—The maxillary teeth in a series of nine specimens examined vary in number from 12 to 15 (av. 13.6), the last two of which are about twice as large as the rest and separated from them by a distinct interspace. In one specimen the mandibular teeth were 18 on each side, the palatine 9 on each side, and the pterygoid 26 on the one side examined.

HABITAT

The earliest report on the habitat of this species is that of W. E. Taylor (1892, p. 356), who says, writing for southeastern Nebraska, that these little snakes, popularly known as "young blue racers," . . . are "rather common and usually found under rocks and around old logs and stumps." This habitat is confirmed by most later writers. Dice (1923, p. 52) lists it among species found in the "rocky-ground community" in Riley County, Kansas. E. H. Taylor (1929, p. 54) refers to it as "surprisingly common" in eastern Kansas "in habitats occupied by the worm snake during the latter part of March and April," and he has also found it in abundance in Swope Park, Kansas City, Missouri. On the other hand Gloyd (1928, p. 121) finds it "surprisingly uncommon" in Franklin County, Kansas; "Only five specimens were secured here in three years collecting. These were under stones or logs on hillsides covered with open woods."

In the vicinity of Tulsa, Oklahoma, Miss Force (1930, p. 30) has found it "quite abundant . . . . under paper, tree trunks, leaves, rotted logs, and in gravel and sand of the railroad tracks." Ortenburger (1930, p. 182) writing for western Oklahoma says that it is usually seen in the

evening as it is getting dark, and most commonly on old unused roads or paths through the woods." Strecker (1924, p . 42) says that "it is a common species in the Ozark Mountains of Missouri and Arkansas, and is usually found under logs and stones." In Missouri Hurter (1911, p. 188) found the ring-neck snake "rather common but never found outside of its cover. It occurs mostly under rocks and logs. I once found one in the mold inside of a rotten tree stump. Another time on turning over a rock, about 2 feet by 18 inches, I found 17 specimens (May 1, 1898) ." Brennan (1934, p. 191) reports "14 under a flat rock near Schoenchen," Ellis County, Kansas, on April 11, 1932. This gregarious habit has been confirmed by Dr. Jewell (see below) and by Burt (1927, p. 4) who reports finding 11 specimens under three flat rocks within a few feet of each other at Manhattan, Kansas, April 25, 1925. Although this may be related to mating activities it is also a feature of other seasons; at least it has been so observed for *edwardsii* by Langiois (1925, p. 606) and by the writer (1927, p. 281) .

In Kansas, Minna E. Jewell and Charles E. Burt have collected many specimens in Riley County and other places. Dr. Jewell informs the writer that in the vicinity of Manhattan "they are always found under stones on hillsides, most numerous near the brow of the hill. They are quite abundant here, so are collected in considerable numbers by the classes each spring and fall. In order not to deplete the collecting I have them turned loose where they came from after a day or two each time. The best collecting I recall was on a southeast exposure near the top of a dry grass-covered hill, in fact right along the brow of the hill, where three students picked up over a dozen specimens in the course of about half an hour. On this occasion five snakes were found under two rocks which were close together (three under one and two under the other). In several other cases I have noticed that several snakes may be found in a small area and then the class may go for some distance before finding more.

HABITS

Food. Regarding their feeding habits W. E. Taylor (1892, p. 346) states that he has "not often been able to determine the contents of their stomachs" but that "their food seems to be principally small larvae, insect eggs, etc." Hurter (1911, p. 188) says that they feed on insects. Guthrie (1926, p. 171) says that "the food of the ring-neck snakes is made up largely of insects," and that "it also includes worms, reptiles, frogs and toads." Dr. Jewell has informed the writer that "they always have refused food in captivity but probably because the wrong food was

offered them. Crickets and ground beetles have been left with them over night, but were always there the next day. The specimens used may, however, have been too large." Miss Force (1930, p. 30) reports discovery of a ring-neck snake " under a rock in the act of eating an earthworm." It has been the writer's experience that these snakes will take earthworms and red-backed salamanders *(Plethodon cinereus)* fairly readily in captivity.

Number of Eggs. The number of eggs in a total complement of this species has varied from 1 to 4 in the few cases known. Miss Force has reported the laying of one set of four and two of one each at Tulsa, Oklahoma (1930, p. 30) . The writer has records of three laid by a Kansas City specimen, three by a Manhattan, Kansas specimen, and two by a female from Tulsa, Oklahoma. In addition, dissections have shown two eggs in each of four specimens, three eggs in two specimens, and four in two others. These all sum up as follows: one egg in two cases, two eggs in five cases, three eggs in four cases, and four eggs in three cases.

Description of Eggs.--The eggs look much like those of *edwardsii in* being white with yellow ends or pale to deep yellow all over, but they are much longer and more slender. Measurements at hand for fresh eggs are listed in Table **III.**

Table III. Measurements of Fresh Eggs of *D. p. arnyi.*

Lengths mm.	*Widths* mm.	
16	6	(Averages from set of four eggs)
37	7	(Only a single egg laid)
52	7	" " " "
28	6.5	
26	6.4	Set of three eggs
27.5	6.1	
22.4	7.6	
22.8	7.0	Set of three eggs
21.0	6.7	
32.5	7.5	Set of two eggs
30.9	7.3	

The first three measurements recorded above were reported by Force (1930, p. 30).

The eggs increase in size after being laid, as shown by the writer for *edwardsii* (1926, p. 283) . This is brought out clearly in Table IV in which measurements are given for intervals of one week.

Table IV. Increase in Size of Eggs of *D. p. arnyi,* Measured at Intervals of One Week. Lengths and widths in millimeters.

Date	*Egg No. 1*		*Egg No. 2*		*Egg No. 3*	
Set No. I						
July 27, 1926 (Date of laying)	28.0	6.5	26.0	6.4	27.5	6.1
Aug. 3	28.8	6.9	27.6	6.3	29.1	6.7
" 10	29.8	6.5	27.8	6.3	29.6	6.3
" 17	31.0	8.3	28.1	8.2	30.9	8.3
" 24	31.9	9.2	29.0	9.0	31.1	9.3
" 31	31.0	9.1	28.5	8.1	29.9	8.6
Sept. 7	32.0	9.2	29.3	8.3	30.6	8.6
t,	33.1	9.9	29.9	8.6	30.4	8.5
" 21	33.0	9.3	29.2	8.1	30.6	8.7
Set No. II						
Aug. 18, 1926 (Date of laying)	22.4	7.6	28.8	7.0	21.0	6.7
Aug. 25	23.5	8.2	23.1	7.8	21.6	8.1
Sept. 1	22.9	9.0	23.7	8. /	22.2	9.1
" 8	23.4	9.4	23.9	8.6	22.5	9.9
" 15	23.9	9.4	24.0	8.0	21.9	9.8
" 22	24.2	9.4	24.0	8.1	23.1	10.1

Dates of Laying. The only date for egg-laying that may be regarded as fairly near the normal is June 20 reported by Force (1930, p. 30) . Specimens kept by the writer in northern Michigan laid eggs about July 24, 1926, July 27, 1926, August 16, 1926, and July 20, 1931. Two of the 1926 eggs hatched in 70 days, and those of 1931 in 54 and 55 days.

The Young Snakes. The young snakes at hatching look practically like the adults. Four specimens measured 98, 104, 105 and 108 mm. in total length .

It is possible that Linsdale found a natural nesting site of this species in Doniphan County, Kansas, for he reports (1927, p. 78) that "several young were found in a hole in the ground at the side of a road by road workers on September 1, 1923."

Length of Subadult Life. As to the length of subadult life in *arnyi* a little speculation may not be out of place. Most of the collections from which measurements were obtained were made in the spring, about the month of May. A great majority of the small individuals collected at this season are a little longer than newly hatched snakes, and the curve of their lengths centers at about 140 or more millimeters (Fig. 17, p. 72).

The next place where a group is suggested by the graph is at about 190 to 200 millimeters. If this group is one year older and still immature, as is most probable, then the smallest sexually mature individuals are about two and a half years old, assuming sexual maturity to be reached in the spring.

Rate of Growth. Opportunity for some interesting speculation on rate of growth is provided by the diagrams of total lengths (Fig. 17, p. 72), particularly by the largest diagram, that of males in Oklahoma. If the young are hatched in the middle of August the smallest individuals collected in May represent this group after a half season of growth. The diagram of Oklahoma males shows this group centering at about 140 mm. in total length. This is an increase of about 35 mm. from the length at hatching, or an increase for the first half season at an annual rate of 67 per cent. The three succeeding groups center at 140, 230 and 250 mm., and represent annual increases at the rates of 36, 21, and 9 per cent respectively. Each succeeding year represents a decrease of about 50 per cent in annual rate of growth. These results may perhaps be accepted tentatively for comparison with more satisfactory figures of this sort, when such become available.

Use of Tail. It is of interest to record that when specimens are handled they often raise the tail in a spiral with the red side uppermost, as has been described of some of the western species. This seems to be the only member of the *punctatus* group that does this.

Taking to Water. The only observation of any ring-neck snake voluntarily (?) taking to water is furnished by Dr. A. I. Ortenburger. He caught one in the act of swimming across West Cache Creek, Oklahoma, in June, 1926.

RANGE

Present evidence indicates that this form of *Diadophis* is a common snake in most of Missouri, eastern Kansas, central and eastern Oklahoma, and the higher parts of Arkansas. Its known range may be stated as from western Illinois and southwestern Wisconsin west into eastern Colorado, and south into east central Texas (Map 4, p. 68).*

***[Reported from southeastern Minnesota by Breckenridge (1942, p. 128).]**

MATERIAL EXAMINED

ARKANSAS: MCZ 371. *Benton* Co.—Sulphur Springs, MZUM 60102. *Carroll* Co.-USNM 55766-7; Eureka Springs, MZUM 60103. *Lawrence* Co.—Imboden, CBS 269-73.

COLORADO: *Los Animas* Co.—Trinidad, CSTC (1).

ILLINOIS: Southern Illinois, USNM 7487. *Rock Island* Co.—Rock Island, USNM 1898. *Union* Co.—Alto Pass, CAHN (1) .

IOWA: *Green* Co.—MCZ 12785-6. *Hamilton* Co.—Webster City, USNM 9766. *Plymouth* Co.—MZUM 52202. *Polk Co.—Des* Moines, USNM 13917 (2).

KANSAS: USNM 51575. Between Fort Riley and Pike's Peak, ANSP 3456. *Anderson* CO.-KU 141; Hyatt, USNM 1968 (Type) . *Cowley* Co.—Winfield, KU 272. *Doniphan* Co.—Geary, CAS 10746. *Douglas* Co.—Lawrence, KU (1) . *Franklin Co.* -OTTAWA 921-2. *Gove Co.*— KU 153. *Hamilton* Co.—USNM 51575. *Neosho Co.*—KU 281. *Riley* Co.—KSC 2786 (7), 3434 (2), USNM 72386; Manhattan, CAS 11267, KSC 2443, 2869, MCZ 5425 (2), MZUM 56261, USNM 71494. *Wallace* Co.—Wallace, MCZ 9502. Also a large series in the writer's private collection representing the following localities: *Bourbon* Co.--Xenia; *Chautauqua* Co.—Cedarvale; *Cherokee Co.*—Baxter Springs; *Cowley* Co.—Winfield; *Marshall* Co.—Irving; *Pottawatomie Co.*—Rocky Ford.

MISSOURI: *Barry* Co.—Washburn, USNM 80976-7. *Boone* Co.-KU (1), USNM 55775. *Crawford Co.*-USNM 55769. *Franklin* Co.-BOYER-HEINZE (1) . *Jasper Co.* -USNM 55774. *Jefferson Co.*-KU (1), FMNH 2659-60, CM 4871-2, USNM 37042-3, 55776-7. *Montgomery Co.*—USNM 55772-3. *St. Louis* Co.--USNM 55770; St. Louis, MCZ 6731, USNM 16234-5. *Stone Co.*-USNM 55771. Also specimens in the writer's private collection representing the following localities: *Jackson* Co.—Kansas City; *St. Louis* Co.—Meramec Highlands and Kirkwood.

NEBRASKA: *Knox Co.*—Mouth of Ponca Creek, S. DAK. 17355.

OKLAHOMA: *Carter Co.*—Ardmore, UOMZ 532-5. *Comanche Co.*—Ft. Sill, MZUM 52417; Whichita Nat. Forest near Camp Boulder, UOMZ 4092; [?] near mouth of Cache Creek, USNM 2077. *Creek* Co.—Drumright, UOMZ 536. *Kingfisher Co.*—Hennessey, ANSP 3470-1. *Le Flore* Co.—Wister, AMNH 4214. *Mc Clain* Co.—UOMZ 19032-9. *Okmulgee* Co.—MZUM 63903-13, and a large series in the writer's private collection. *Tulsa* Co.—Tulsa, UOMZ 380-1, TULSA 9-10, 14, 21, 27, and a large series in the writer's private collection. *Woodward* Co.—Quinlan, UOMZ 18900.

TEXAS: Head of Trinity River, USNM 2076 (Cotype of *D. texensis* Kennicott) . *Bexar* Co.—Bexar, BAYLOR 66; Helotes, BAYLOR 183* (2) . *Bosque* Co.—Clifton, CM 1074-83; Valley Mills, BAYLOR 5043; Union Hill, BAYLOR 3799. *Colorado Co.*—Rock Island, KU 1947 (intergrade with *stictogenys)* . *Dallas* Co.—Dallas, ANSP 10782, MCZ 2505-6. *Donley Co.—S.* of Clarendon, ANSP 10787. *Mc Lennan* Co.—China Springs, BAYLOR 5023; Tonkaway Creek, BAYLOR 3918, 3972. *Medina* CO.-FNB (1).

WISCONSIN: *Grant* Co.—Wyalusing, MPM 1566.

*[Dr. Leo T. Murray, curator of the Strecker Museum, Baylor University, in a letter dated March 16, 1942, states that the records do not show a number 66 or 183. However, he sent for examination two specimens (BAYLOR 613 and 614) from Helotes, collected by Marnock, which in number of ventrals and caudals correspond to the counts recorded by Dr. Blanchard. It is possible that these are the specimens seen by him and that they have been renumbered. They are apparently typical *arnyi.]*

Published records for localities not represented by specimens examined in this study are as follows:

ARKANSAS: *Garland* Co.—Hot Springs, Hurter and Strecker (1909, p. 25). *Logan* Co.—Magazine Mountain, Stone (1903, p. 541).

ILLINOIS: *[Randolph* Co.—Chester, and *Jackson* Co.–Grand Tower, Cagle (1942, p. 186).] *St. Clair* Co.—Hurter (1911, p. 188).

IOWA: *Jones, Lee,* and *Story Counties,* Guthrie (1926, p. 171).

KANSAS: *[Chase* Co.—Breukelman and Downs (1937, p. 268). *Clark Co.*—Bluff Creek, Hibbard (1937, p. 74).] *Dickinson* Co.—Abilene, Ellis and Henderson (1913, p. 101, pl. 4, *fig.* 21). *Ellis* Co.—Schoenchen, Brennan (1934, p. 191). *[Lyon* Co.—Breukelman and Downs (1937, p. 268).] *Mitchell, Mc Pherson, Scott,* and *Wyandotte Counties,* Branson (1904, p. 4081. *Shawnee* Co.—Topeka, C ragi n (1881, p. 120). *Leavenworth, Montgomery,* and *Osage Counties,* Taylor (1929, p. 54) . *Miami* Co.—Pigeon Lake, Gloyd (1932, p. 402).

[MINNESOTA: *Winona* Co.—Breckenridge (1942, p. 128).]

MISSOURI : *Butler, Gasconade, Iron, Jackson, Randolph* and *Washington Counties,* Hurter (1911, p. 188). *Christian* Co.—Chadwick, Stone (1903, p. 541). *Macon* Co.--Macon, Van Wagenen (1917, p. 43).

NEBRASKA: *Howard* Co.—Dury (1931, p. 28). *Cass* and *Nemaha Counties,* Taylor (1892, p. 345).

OKLAHOMA: *Le Flore* Co.—Sugar Loaf Mountain, Stone (1903, p. 541); [Spring Mountain, Trowbridge (1937, p. 295)]. *Murray* Co.—Dougherty and Arbuckle Mountains, Ortenburger (1926, p. 84); [Sulphur, Smith and Leonard (1934, p. 193)].

SOUTH DAKOTA *Bon Homme* Co.—Springfield, Over (1923, p. 26).

VARIATION

Differences between the Sexes. The chief normal variations not included in the description above are related to sex, and are most noticeable in the numbers of ventrals and caudals, proportionate length of tail, and anal ridges. The ventrals in males are usually 162 or less, and in females they are usually 163 or more. This is the case in 92 per cent of 784 specimens examined. One female with a low number of ventrals came from Des Moines, Iowa, and several from localities adjacent to the range of *stictogenys:* St. Louis, Missouri; Imboden, Arkansas; and Dallas, Texas.

In the number of caudals there is less difference between the sexes. Most of the females have fewer than 47 caudals (av. 40) and most of the males have more than 41 (av. 46) .

By subtracting the number of caudals from the number of ventrals the difference between the sexes is emphasized and, out of 823 specimens examined, 98 per cent agree with the following rule: *If the difference between the number of ventrals and the number of caudals is 119 or less, the specimen is a male; if the difference is 120 or more, it is a female.* Only

six males out of the whole number examined (462) had a difference between the ventrals and caudals greater than 119. In two it was 120, in three 121, and in one it was 122. Eleven females out of 361 had less than 120. The lowest was 109. The localities from which these low differences came were well scattered, but none were in Oklahoma. In this state there is no overlapping of the sexes in this feature if the rule be revised to read: the difference between the ventrals and caudals in males is 120 or less, in females 121 or more. This is based on 489 specimens.

In over 90 per cent of the specimens measured the sex can be correctly determined by the length of the tail compared with the total length of the snake. If the tail length divided by the total length is .170 or more, the specimen is a male; if it is .169 or less, it is a female.

The presence of anal ridges is less useful in determining sex because, although most males over 210 mm. in length have them, some do not. Of those shorter than 210 mm. about half possess anal ridges. An occasional female shows them. These structures have been already discussed above.

Number of Scale Rows. That the scale formula does not differ between the sexes is well shown in Table V. Here the different formulas are summarized by sex and by region. The commonest formula, 17-15, occurs in 63 per cent of each sex. Seventeen rows throughout the body length occurs in 15 per cent of all specimens but is commoner in females; and the reduced formulas 15-15 and 15-17-15, although well represented in both sexes, are a little more frequent in males. A maximum of 19 rows has been found in one specimen, a male, from Clifton, Bosque County, Texas. In this the formula of 17-19-17 is reminiscent of *dugesii* of Mexico.

The number of scale rows varies more with locality than any of the other characters studied. While 17-15 is the common scale row formula in Missouri, eastern Kansas, Arkansas, and eastern Oklahoma, specimens taken west of this region show a large majority of 15-15 formulas. This is particularly well demonstrated by a good series of specimens from central Oklahoma (Table V) and is indicated by scattered specimens from western Oklahoma, western Texas, western Kansas, and Colorado. In spite of this marked tendency to 15 rows of scales in the western parts of the range of this form, it does not seem possible to link with it any other characters sufficient to delineate a separable subspecies. In the east and southeast of the range, however, a tendency to only 15 rows of scales has combined with several otherchanges to develop the subspecies *stictogenys.*

Table V. Geographic Variation in Scale-row Formula in *D. p. arnyi.*

Region		Scale-row Formula								Totals	
		15-15		15-17-15		17-15		17-17			
		♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
Northeastern Okla.: *Tulsa, Okmulgee, Creek, Latimer and Delaware Counties*	No. of Specimens	12	2	10	4	158	115	22	30	202	151
	Per cent of Total	5.9	1.3	4.9	2.6	78.2	76.1	10.0	19.9	99.9	99.9
Central Okla.: *Logan, Cleveland, Payne and Kingfisher Counties*	No. of Specimens	50	28	1	1	12	10	1	0	64	39
	Per cent of Total	78.1	71.8	1.6	2.6	18.8	25.6	1.6	0	100.0	100.0
Southeastern Kans.: *Cowley, Cherokee, Chautauqua, Bourbon, Anderson, Labette and Neosho Counties*	No. of Specimens	3	0	14	5	34	29	1	3	52	37
	Per cent of Total	5.8	0	26.9	13.5	65.4	78.4	1.9	8.1	100.0	100.0
North-central Kans.: *Riley, Marshall and Doniphan Counties*	No. of Specimens	6	3	14	5	43	17	1	2	64	27
	Per cent of Total	9.4	11.1	21.8	18.5	67.2	63.0	1.6	7.4	100.0	100.0
Kansas City, Mo. and *Douglas and Franklin Counties, Kans.*	No. of Specimens	1	1	4	1	26	22	1	4	32	28
	Per cent of Total	3.1	3.6	12.5	3.6	81.2	78.6	3.1	14.3	99.9	100.1
Eastern Mo.: *St. Charles, St. Louis, Jefferson, Montgomery and Boone Counties*	No. of Specimens	1	1	6	4	14	11	0	4	21	20
	Per cent of Total	4.8	5.0	28.6	20.0	66.7	55.0	0	20.0	100.0	100.0
	Total No. of Specimens	73	35	49	20	287	204	26	43	435	302
	Per cent	17.9	15.5	16.1	10.1	62.9	62.8	3.4	11.6	100.0	100.0

Ventrals. The ventrals tend to be more numerous in specimens from the western part of the range and to be less numerous on the eastern and southeastern periphery. There is a difference of about six between the averages for Tulsa, Oklahoma, and St. Louis, Missouri. Specimens from Imboden, Lawrence County, Arkansas, actually have ventral counts characteristic of *stictogenys* while their scale rows are like *arnyi*. The increase in number of ventrals to the west is not pronounced in localities from which good series of specimens are available. From Tulsa to Guthrie, Oklahoma, for example, there is an increase of only one in males and two in females (Table VI). A summary of number of ventrals for localities from which good series of specimens are at hand is given in Table VI.

Table VI. Variation in Number of Ventrals in Different Parts of the Range of *D. p. arnyi.*

Region	Males			Females		
Vicinity of:	*Number of Specimens*	*Ventrals Extremes*	*Averages*	*Number of Specimens*	*Ventrals Extremes*	*Averages*
Tulsa, Okla.	184	146-169	156.3	139	160-185	169.8
Guthrie, Okla.	63	148-165	157.2	39	164-185	172.0
Winfield, Kans.	51	146-169	156.5	35	160-177	169.7
Manhattan, Kans.	55	151-168	157.2	22	161-175	170.5
Kansas City, Mo.	33	147-159	153.3	29	159-173	165.6
St. Louis, Mo.	21	144-155	149.6	20	158-168	164.0
Summary	407	144-169	156.0	284	158-185	169.3

Labials. The labials are usually 7 above and 8 below but there is a 6 per cent variation from this figure in the upper series and a 16 per cent variation in the lower. The principal variation in the upper labials is to 8, but occasional specimens have only 6. The chief variation in the

Table VII. Variation in Number of Labials in *D. p. arnyi.*

Labial Formula	6-6*	6-7	7-6	7-7	7-8	8-7	8-8	9-8	9-7	Totals
Upper Labials										
Number of Specimens	6	4	0	787	14	14	14	0	0	839
Per cents of Total	0.7	0.5	0	93.8	1.7	1.7	1.7	0	0	100
Lower Labials										
Number of Specimens	1	1	3	70	28	25	700	3	1	832
Per cents of Total	0.1	0.1	0.4	8.4	3.4	3.0	84.1	0.4	0.1	100

lower labials is to 7. Eight and a half per cent of all specimens have 7 on each side and about 6 per cent have 7 on one side and 8 on the other. The remaining variations, to 6 and 9, are rare. Variation in the labials seems to be well distributed over the range of the subspecies for there is only 2 per cent more variation from the normal 7-8 formula outside the state of Oklahoma than within it. Table VII summarizes the variation in labials.

Temporals.— The temporals are 1+1 in the great majority of specimens, but 2 per cent have 1+2 and nearly as many more have 1+1 on one side and 1+2 on the other. Where there are two temporals in the second row, the upper is the smaller. In six specimens the first temporal is united with the parietal on both sides and in two it is so united on one side. In five specimens the first and second temporals are fused end to end on one side of the head.

Unusual Variations. Certain types of rare and sporadic variation may be regarded as abnormalities. Thus, three individuals have the anal plate undivided; an occasional one has the preanal divided, sometimes irregularly; one has a scale row formula of 15-17-13, another, 17-17-19; a few exhibit fusions of the pairs of caudals, or irregular divisions of a few ventrals. Various fusions, partial or complete, are found in the head plates. For example, the labials are sometimes reduced to six; the first temporal is sometimes united with the parietal; both the preoculars and the postoculars are in a few cases united.

Relationships with Adjacent Subspecies. Arnyi shows evident approach to *stictogenys* in specimens from Dallas, Helotes and Rock Island, Texas and Imboden, Arkansas. In these places the scale rows are 15-15 or 15-17-15 and the number of ventrals is low. An important point noted in the Imboden specimens is the marked restriction in extent of the dark mark around the angle of the jaw. In one specimen it is absent. These specimens are practically intergrades. Were it not for their 17 rows of scales they could well be called *stictogenys.*

The range of *arnyi* adjoins also that of *edwardsii.* A specimen from Wyalusing, Grant County, Wisconsin (MPM 1566), seems to be typical of *arnyi.* The scale rows are 15-17-15, the ventrals are like *arnyi* and too high for *edwardsii,* the difference between the ventrals and caudals is typical of *arnyi* and wholly unlike *edwardsii,* and its proportions of body and tail are also like *arnyi.* The next geographically nearest Wisconsin specimen of *Diadophis* is from Clark County (AMNH 17083). This is a typical *edwardsii.* A specimen from Rock Island, Illinois (USNM 1898),

is assignable only to *arnyi*. These records apparently establish the occurrence of *arnyi* east of the Mississippi River.

More special account must be taken of a *Diadophis* collected recently at Alto Pass, Union County, Illinois (private collection of A. R. Cahn) . This specimen from extreme southwestern Illinois has 161 ventrals, 44 caudals, 7 labials in each series on each side, only 15 rows of scales, tail .160 of the total length, prominent spots on the belly scattered but tending to be in a single line, small spots on lower labials, and the dark mark around the angle of the jaw about half developed. This may be identified with certainty as *arnyi,* but it shows departure from the normal for that form in the somewhat low number of ventrals and high number of caudals, the 15 rows of scales and the recession of the head markings. If it were not for a second specimen of *Diadophis* collected at the same place and time, little significance could be attached to its slight leanings toward *edwardsii.* The second specimen is a small female with 159 ventrals, 49 caudals, 15 rows of scales, immaculate belly, no mark around the angle of the jaw, a few small flecks on the lower labials, and the tail .185 of the total length. This is clearly *edwardsii,* but in the flecks of black on the lower labials and the relative tail length it shows a leaning toward *arnyi.* These two specimens together show that the possibility of intergradation or hybridization between *arnyi* and *edwardsii* cannot be denied.*

AFFINITIES

Since the relationships of this form can best be discussed after the other members of the group have been described, this subject will be found treated to some extent under *stictogenys* and more extensively under *edwardsii.* To summarize briefly in advance, it may be stated that *arnyi* is most closely related to *stictogenys,* and in all probability it intergrades with this form. With the other members of the *punctatus* group it is only indirectly allied.

Outside the *punctatus* group it bears a close relationship [through *docilis*] with the Mexican species *dugesii,* and with this form only. In support of this, attention may be called to the fact that the scale row formula of *arnyi* is characteristically that which represents the lower limit of

*[Three specimens collected in the Pine Hills region, 2 miles east of Aldridge, Union County, Illinois, April 20, 1942 (CA 10971-3) are fairly typical of *arnyi* in structural characters but in the spotting of the belly show tendencies toward *stictogenys.* More material from southern Illinois must be collected before the status of the ringneck snakes in this region can be determined satisfactorily.]

variation in *dugesii,* and that the common variation in scale rows in the center of the range in *arnyi* is to that formula most characteristic of *dugesii,* and occuring in no other form of *Diadophis;* i. e., 17-17. The number of ventrals in the two forms is not strikingly different. The two forms agree in the extension of the dorsal color over the lowermost row of dorsal scales, and in the extension of the head color around the angle of the jaw and somewhat forward on the lower jaw. The spotting of the belly is practically the same, except that in *arnyi* a tendency to specialization is seen in the frequency of aggregation of the spots into symmetrical double or single series. The maxillary teeth are the same, except that in *arnyi* there is a tendency to increase the number and shorten the interspace. In the red color under the tail, *arnyi* is identical with the western races of *regalis* and *amabilis* and unlike the other forms of *punctatus* [except *docilis].* Presumably this red color is possessed by *dugesii,* but this is uncertain, due to a lack of fresh specimens.

In short, the differences between *dugesii* and *arnyi* are relatively slight; are less, in fact, than between *dugesii* and any other species in the genus; and these differences are in the nature of a specialization in *arnyi.* Therefore, *arnyi* is to be regarded as a derivative of dugesii [through *docilis],* and as a progenitor of the other members of the *punctatus* group.

Diadophis punctatus stictogenys Cope

Mississippi Valley Ring-neck Snake

Fig. 19

1860. *Diadophis punctatus stictogenys* COPE, Proc. Acad. Nat. Sci. Philadelphia, p. 250 (Type locality unknown. Type specimen in Academy of Natural Sciences, Philadelphia; collector unknown.) ; Bull. U. S. Nat. Mus., no. 1, 1875, p. 37, 81; *idem,* no. 17, 1880, p. 23.-YARROW, Bull. U. S. Nat. Mus., no. 24, 1882, p. 15, 190; Smiths. Misc. Coll., no. 517, 1883, p. 15.-BLANCHARD, Occ. Papers Mus. Zool. Univ. Mich., no. 117, 1922, p. 9.-STEJNEGER AND BARBOUR, Check List, ed. 2, 1923, p. 83.-BLANCHARD, Papers Mich. Acad. Sci. Arts, Let., vol. 4 (1924), 1925, pt. 2, p. 34.-CORRINGTON, Copeia, no. 165, 1927, p. 100.-JONES, Journ. Tenn. Acad. Sci., vol. 3, 1928, no. 2, p. 12.--STRECKER AND WILLIAMS, Contrib. Baylor Univ. Mus., no. 17, 1928, p. 15.-VAN CLEAVE, Trans. Ill. Acad. Sci., vol. 20, 1928, p. 134, table 2.-JORDAN, Man. Vert. Animals, ed. 13, 1929, p. 236.-ALLEN, Amer. Mus. Novit., no. 542, 1932, p. 13.-DURY, Proc. Jr. Soc. Nat. Sci. Cincinnati, vol. 3, 1932, no. 2, p. 28.-STEJNEGER AND BARBOUR, Check List, ed. 3, 1933, p. 90; ed. 4, 1939, p. 99.-*Diadophis amabilis stictogenys* COPE, Proc. U. S. Nat. Mus., vol. 14, 1892, p. 616; Amer. Nat., 1896, p. 1009; Ann. Rep. U. S. Nat. Mus. (1898), 1900, p. 750, fig. 161.-WRIGHT AND BISHOP, Proc. Acad. Nat. Sci. Philadelphia, 1915, p. 148, 153.

1860. *Diadophis texensis* KENNICOTT, Proc. Acad. Nat. Sci. Philadelphia, p. 320 (Type specimen, designated by Cope, 1900, p. 748, USNM 1897. Type locality "New Orleans to Galveston"; specimen received from Prof. E. B. Andrews) . -STRECKER, Baylor Univ. Bull., vol. 18, 1915, no. 4, p. 38.

1883. *Diadophis punctatus amabilis* DAVIS AND RICE, Bull. Chicago Acad. Sci., vol. 1, no. 3, p. 29.

1892. *Diadophis punctatus* GARMAN, H., Bull. Ill. St. Lab. Nat. Hist., vol. 3, p. 301. -HURTER AND STRECKER, Trans. Acad. Sci. St. Louis, vol. 18, 1909, no. 2, p. 25.-BRIMLEY, Proc. Biol. Soc. Washington, vol. 23, 1910, p. 13.—LODING, Ala. Mus. Nat. Hist., Paper no. 5, 1922, p. 27 *(part).—Coronella punctata* (part) BOULENGER, Cat. Snakes Brit. Mus., vol. 2, 1894, p. 207.

1900. *Diadophis amabilis docilis* COPE, Ann. Rep. U. S. Nat. Mus. (1898) , p. 748, *fig.* 159 (Type of *D. texensis)* .

1908. *Diadophis regalis* STRECKER, Proc. Biol. Soc. Washington, vol. 21, p. 73; Baylor Bull., vol. 18, 1915, no. 4, p. 37.

1909. *Diadophis regalis arnyi* HURTER AND STRECKER, Trans. Acad. Sci. St. Louis, vol. 18, no. 2, p. 25.

1915. *Diadophis amabilis* (part) STRECKER, Baylor Bull., vol. 18, no. 4, p. 38.

DESCRIPTION

Diagnosis. This form is marked by 15 dorsal scale rows, 7 upper labials, generally less than 145 ventrals, belly more or less irregularly black-spotted, and neck ring narrow and often interrupted.

Scutellation. The scutellation of 73 specimens is as follows: ventrals 126 to 150 (males 126-143, av. 133; females 137-150, av. 142) ; caudals 33 to 51 (males 38-51, av. 46; females 33-43, av. 39) ; upper labials 7, rarely 8 or 6; lower labials 8 or 7; preoculars 2, rarely 1; postoculars 2, rarely 1; temporals 1+1, occasionally 1+2; posterior chin shields in contact, a little shorter than the anterior; scale rows 15 throughout (except rarely 13-15-13, 14-15-14, 15-14, or 15-13) .

Form and Size. The body is relatively short, nearly cylindrical, little if any widened at the temples, and tapering a little towards the rather short tail. The latter varies from .148 to .241 of the total length (males .178-.241, av. .207; females .148-.201, av. .169) . The largest specimen examined, a female, measured 364 mm. and was collected near Mobile, Alabama. The lengths of all specimens examined are shown in Fig. 20.

Coloration. The general coloration is a bluish slate above extending over the first row of scales, and onto the ends of the ventral plates as a series of short bars. The head is generally a little darker than the rest of the dorsal surface, except that occasional specimens are more or less

mottled with lighter color. The darker color not infrequently extends around the angle of the jaw, as in *arnyi*. The under surface of the body is yellowish, variously spotted with black. These spots are frequently more or less irregular in shape and distribution but in most specimens they are plainly aggregated along the middle of the belly, forming twos

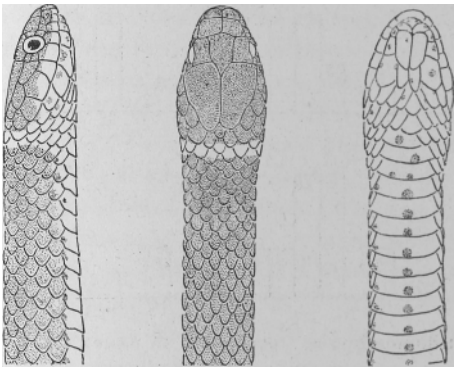


Fig. 19. *D. p. stictogenys,* FNB, Covington, St. Tammany Parish, Louisiana.

or double ones, but apparently never into a perfect line of regularly formed spots as in typical *punctatus* from Florida. The under side of the tail in the majority of specimens is unspotted. The under side of the chin and lower labials, however, are in every case more or less specked with black. The neck ring is narrow, varying from one-third to one and one-half scales in width, and is frequently interrupted.

The actual colors of a living specimen from Mobile, Alabama, were noted as follows: belly Ochraceous-Orange, anteriorly becoming lighter to Ochraceous Buff; neck ring about the same color as the belly; upper surface of body black; head Sooty-Black above. One from Covington, Louisiana, was orange below, a deeper orange on the neck ring; the under side of the tail was like the belly in color.

Dentition.—The dentition as revealed by the examination of a small series of specimens is as follows: maxillary teeth 15 to 21, the last two nearly or quite twice as large as those that precede and separated from them by a slight to wide interspace; mandibular teeth 23; palatine teeth 13.

HABITAT AND HABITS

In Louisiana, which may be considered a typical portion of its range, "it seems confined to the pine lands and uplands," according to Percy Viosca, Jr., who goes on to say: "We have not yet obtained any specimens in the alluvial section." Corrington collected several specimens under the loose bark of fallen pine trunks near Biloxi, Mississippi (1927, p. 100).

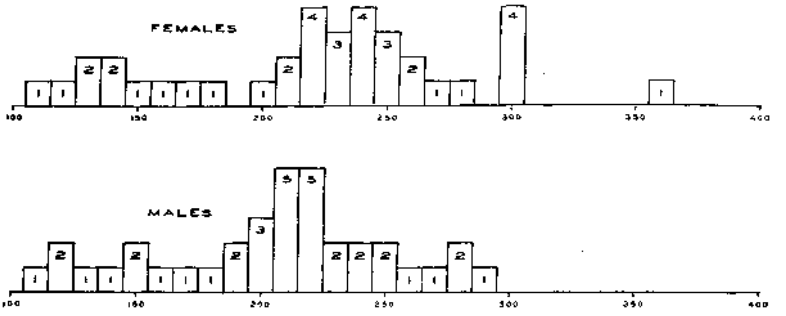


Fig. 20. Distribution by size (total length to nearest 10 mm.) and sex of 72 specimens of *D. p. stictogenys.*

DISTRIBUTION

Range. The geographic range of this form extends from the west side of Mobile Bay northward, west of the Tennessee River into extreme southern Illinois, thence southwestward, south of the Ozark uplands, into and perhaps throughout the eastern forested portion of Texas (Map 4, p. 68) .

MATERIAL EXAMINED

ALABAMA: *Bibb* Co.—Pratt's Ferry, ALA (2) (intergrades with *punctatus)* . *Colbert* Co.—Leighton, USNM 51221 (intergrade) . *Jefferson* Co.—Cohort, ALA (8) (intergrades) . *Lawrence Co. —Moulton,* USNM 9720 (intergrade) . *Mobile* Co.-USNM 56457, Mobile, ALA (3), MCZ 283, MZUM 6090944, USNM 56455-6. *Shelby* Co.-ALA (1) (intergrade) . *Tuscaloosa* Co.—University, ALA (19) (intergrades) .

ARKANSAS: *Clay* Co.—Greenway, FMNH 647. *Garland* Co.-USNM 55768.

ILLINOIS: *Alexander* Co.—Olive Branch, FMNH 2223.

LOUISIANA: USNM 6070. *Natchitoches* Parish—Chastine [4 mi. S. of Chestnut] , CORNELL 7386. *Orleans Parish—New* Orleans, USNM 12905, 15376. *Rapides Parish*—Ball, MZUM 60917-9. *St. Tammany* Parish—Covington, MZUM 60920-5; 6 mi. W. of Covington, MZUM 10915-6, VIOSCA (3) ; St. Tammany, VIOSCA (1) . *Washington* Parish—Bogalusa, VIOSCA (1) .

MISSISSIPPI: *Hancock Co.*—*Bay* St. Louis, USNM 38225-6. *Harrison Co.*—Biloxi, CBS 426-7, 555-67, 592-5, FMNH 1883, USNM 7288, 51095, FNB (6). *Lawrence* Co.—Monticello, USNM 2155. *Sunflower* Co.—Hancock, USNM 56312-3. *Webster Co.*—Mathiston, FNB (1) .

TENNESSEE: *Benton* Co.—Camden, MZUM 53117. *Henry* Co.—Henry, MZUM 53385.

TEXAS: *Bexar* Co.—Helotes, BAYLOR 615.* *Colorado* Co.—Rock Island, KU 1947 (intergrade with *arnyi). Dallas* Co.—Dallas, ANSP 10781. "New Orleans to Galveston," USNM 1897 (Type of *D. texensis* Kennicott).

In addition to the localities from which specimens have been examined, the species has been reported from Bowie County, extreme northeastern Texas by Strecker and Williams (1928, p. 15) . Specimens reported from Helotes (Cope, 1880, p. 23), and McLennan County (Strecker, 1908, p. 73) , Texas, may have been referable to *stictogenys.* Garman's record of Warsaw, Union County, Illinois (1892, p. 301) may also have been based upon a specimen of *stictogenys.*

[This subspecies has been recently reported from Jackson County, Illinois by Cagle (1942, p. 186), Fulton County, Kentucky by Parker (1939, p. 82) and by Dury and Gessing (1940, p. 32); Gramercy, St, James Parish, Louisiana, by Meade (1940, p. 165) ; and Obion County, Tennessee, by Parker (1937, p. 70).]

VARIATION AND AFFINITIES

D. p. stictogenys is well set off from its allies both in range and in characters of pattern and structure. It occupies the forested coastal plain country of eastern Texas, and the lower Mississippi Valley to Mobile Bay. Throughout this region there is a marked uniformity in (1) the low number of ventrals, (2) the 15 rows of dorsal scales, (3) the 7 upper labials, (4) the tendency to aggregation of the belly spots in the median line, and (5) the narrow and frequently interrupted neck ring.

Along the periphery of its range, however, it shows striking approach in its characters to the adjacent forms. This is particularly well demonstrated by a series of 33 specimens from western Alabama (see list of material examined) . Most of these individuals have the ventral markings like *stictogenys,* and the upper labials like *punctatus* and *edwardsii.* The

*[This specimen, sent for examination by Dr. Leo T. Murray, Strecker Museum, Baylor University, is not listed by Dr. Blanchard but undoubtedly had been seen by him for it bears a fiber tag with *"Diadophis punctatus stictogenys"* in his handwriting. It is a male with 133 ventrals (much too low for *arnyi)* , 49 caudals, and 15 scale rows. This and a specimen from Rock Island, Colorado County, Texas (KU 1947), considered by Dr. Blanchard as "about on borderline between *arnyi* and *stictogenys,"* furnish acceptable proof of the intergradation of these two forms in south-central Texas.]

neck ring is narrow like both *stictogenys* and *punctatus.* But in the relatively high number of ventrals and the scarcity of interruption in the neck ring they approach *edwardsii.* Satisfactory subspecific determination of these specimens is impossible. None of them are typical of any race of *Diadophis.* They illustrate, on the other hand, what is to be expected in any considerable collection from the border line between two subspecies.

A comparison of the characteristics of *stictogenys* with those of the other subspecies of *punctatus* brings out the following facts. Compared with *arnyi,* it has (1) the same general type of ventral pattern; (2) a generally narrow neck ring; and (3) the same number of upper labials. It is closer to punctatus in (1) its number of dorsal scale rows; (2) its number of maxillary teeth; (3) its often interrupted neck ring; and (4) its lower number of ventrals. It is strictly intermediate between these two forms in (1) its general tendency to aggregation of the ventral spots in the median line; (2) the frequency of interruption of the neck ring; and (3) the proportionate tail length (the average proportionate tail length in *arnyi, stictogenys,* and *punctatus,* is, respectively, for males .188, .207, .215; and for females .155, .169, .180) . With *edwardsii, stictogenys* has in common only one significant feature: 15 rows of scales throughout the body. *Punctatus* possesses this feature also, and is in other important respects much closer to *edwardsii.*

We may sum up the above by saying that *stictogenys* is evidently closely allied to *arnyi* and to *punctatus,* but that there is scant evidence of close affinity with *edwardsii.*

Diadophis punctatus punctatus (Linnaeus)

Southeastern Ring-neck Snake

Fig. 21

1766. *Coluber punctatus* LINNAEUS, Syst. Nat., ed. 12, vol. 1, p. 376 (Type locality Carolina); ed. 13 (Gmelin), vol. 1, pt. 3, 1788, p. 1089.—LACÉPÈDE, Hist. Nat. Serp., vol. 2, 1789, p. 287.—BONNATERRE, Tab. Encycl. Meth., Ophiol., 1790, p. 10.-SONNINI AND LATREILLE, Hist. Nat. Rept., vol. 4, 1799, p. 136.—DAUDIN, Hist. Nat. Rept., vol. 7, 1800, p. 178.—LINNAEUS, Gen. Syst. Nat., vol. 1, 1806, p. 677.—MERREM, Tent. Syst. Amph., 1820, p. 131.—HARLAN, Journ. Acad. Nat. Sci. Philadelphia, 1825, p. 354; vol. 5, 1827, p. 354; Med. Phys. Res., 1835, p. 117.—LACÉPÈDE, Hist. Nat. Quad. Ovip., vol. 1, 1836, p. 220, 297.—HOLBROOK, N. Amer. Herp., vol. 2, 1838, p. 115, fig. 26.—*Natrix punctatus* MERREM, Versuch. Syst. Amph., 1820, p. 131.—*Homalosoma punctatum* WAGLER, Nat. Syst. Amph., 1830, p. 191.—*Calamaria punctata* SCHLEGEL,

Essai Phys. Serp., 1837, p. 39 (part).-*Spiletes punctatus* SWAINSON, Nat. Hist. Fishes, Amph., Rept., vol. 2, 1839, p. 364.-*Diadophis punctatus* BAIRD AND GIRARD, Cat. N. Amer. Rept., 1853, p. 112.-JAN, Prod. Icon. Gen. Ofid., 1863, p. 52, 53-54 (part); Arch. Zool. Anat. Fisiol., 1863, p. 262, 263-264; Elenco Sist. degli Ofidi, 1863, p. 49 (part); Icon. Gen. Ophid., liv. 15, 1866, pl. 6, *fig.* 1.-DUMÉRIL AND BOCOURT, Miss. Sci. Mex., pt. 3, 1886, p. 618, pl. 40, *fig.* 1-le.-LOENNBERG, Proc. U. S. Nat. Mus., 1894, p. 325.-COPE, Amer. Nat., 1896, p. 1008, 1011.--BRIMLEY, Journ. Elisha Mitchell Sci. Soc., vol. 23, 1907, p. 144; Proc. Biol. Soc. Washington, vol. 22, 1909, p. 134; *idem*, vol. 23, 1910, p. 13.-WRIGHT AND BISHOP, Proc. Acad. Nat. Sci. Philadelphia, 1915, p. 148, 151, pl. 3, fig. 1.-STEJNEGER AND BARBOUR, Check List, 1917, p. 76.-DECKERT, Copeia, no. 54, 1918, p. 32.-LODING, Ala. Mus. Nat. Hist. Paper no. 5, 1922, p. 27.--BRIMLEY, Jour. Elisha Mitchell Sci. Soc., vol. 42, 1926, no. 1 and 2, p. 86.-PICKENS, Copeia, no. 165, 1927, p. 111.-*Cornella punctata* BOULENGER, Cat. Snakes Brit. Mus., vol. 2, 1894, p. 206 (part) .

1858. *Ablabes occipitalis* GUNTHER, Cat. Colubr. Snakes Brit. Miss., p. 29 (Type locality Mexico,* designated by Boulenger, 1894, vol. 2, p. 207; type specimen in British Museum.).-*Diadophis occipitalis* COPE, Proc. Acad. Nat. Sci. Phila delphia, 1860, p. 250; Ann. Rep. U. S. Nat. Mus. (1898), 1900, p. 753.

1860. *Diadophis dysopes* COPE, Proc. Acad. Nat. Sci. Philadelphia, p. 251 (Type locality unknown; type specimen in Academy of Natural Sciences, Philadelphia; collector unknown.); Bull. U. S. Nat. Mus., no. 1, 1875, p. 38.--YARROW, Bull. U. S. Nat. Mus., no. 24, 1882, p. 15, 190; Smiths. Misc. Coll., no. 517, 1883, p. 15.-COPE, Ann. Rep. U. S. Nat. Mus. (1898), 1900, p. 752, *fig.* 163.

1886. *Diadophis punctatus* var. *dysopes* DUMÉRIL AND BOCOURT, Miss. Sci. Mex., pt. 3, p. 622.

*The original description of *Ablabes occipitalis*-"Scales in 15 rows; upper labials 7, third and fourth touching eye. Above black; on each side of the neck a yellow streak, not confluent on the occiput; beneath yellowish with 3 rows of small black spots. ad. Mex. ; ad. U. S."-together with the information as to sex, ventrals, and caudals; i. e., female, 149, and 41, respectively, given by Boulenger (1894, p. 207), who designates Günther's first specimen as the type, make it certain enough that the locality "Mexico" is in error. Such a specimen can have come only from the region between coastal and eastern Texas and North Carolina, or, more specifically, from the regions designated in this review as the ranges of *stictogenys* and *punctatus*.

We might with reason attribute this specimen to the range of *stictogenys, in* which case the latter name would become its synonym, for 7 upper labials is highly characteristic of *stictogenys,* and is only an occasional variation in *punctatus*. But two other features are more important. Three rows of small black spots on the ventral surface characterize *punctatus,* and would not ordinarily be found in *stictogenys*. Even though the median ventral spots are occasionally in a single line in *stictogenys,* those on the ends of the ventrals are but poorly represented. Furthermore, the ventrals in the females of *stictogenys* do not reach as high a number as 149 in the Louisianan region, according to the material now on hand, which is the region in the range of *stictogenys* from which specimens would most likely be sent to Europe. On the other hand, 7 upper labials is a common variant in *punctatus* north of Florida, and here, too, a high ventral count is found, as well as the characteristic three rows of ventral spots, and the interrupted neck ring. The most probable locality of *occipitalis is* South Carolina or Georgia.

1919. *Diadophis punctatus punctatus* BARBOUR, Proc. N. Eng. Zool. Club, vol. 7, p. 7.-MYERS, Copeia, no. 131, 1924, p. 61.-BLANCHARD, Occ. Papers Mus. Zool. Univ. Mich., no. 117, 1922, p. 9.-STEJNEGER AND BARBOUR, Check List, ed. 2, 1923, p. 83.-SCHMIDT, Copeia, no. 132, 1924, p. 68.-HOLT, Copeia no. 136, 1925, p. 100.-BLANCHARD, Papers Mich. Acad. Sci. Arts, Let., vol. 4 (1924), 1925, pt. 2, p. 34.-BISHOP, Journ. Elisha Mitchell Sci. Soc., vol. 43, 1928, no. 3 and 4, p. 167.-JoRDAN, Man. Vert. Animals, ed. 13, 1929, p. 236. -CORRINGTON, Copeia, no. 172, 1929, p. 70.-STEJNEGER AND BARBOUR, Check List, ed. 3, 1933, p. 90; ed. 4, 1939, p. 98.

DESCRIPTION

Diagnosis.—The leading characteristics of *punctatus* are 8 upper labials, 15 rows of scales throughout its length, an interrupted neck ring, a single line of dark spots along the belly, and a restriction in the number of ventrals between 127 and 155. It is best distinguished from *stictogenys*

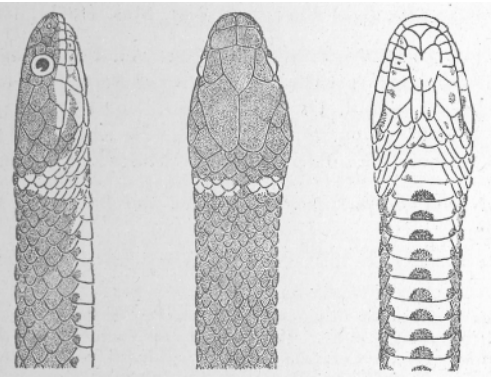


Fig. 21. *D. p. punctatus,* MZUM 52391, Candler, Marion County, Florida.

on the presence of a single median line of dearly defined half-moon--shaped black spots on the belly. In *stictogenys* the ventral spots are more or less scattered, or imperfectly united into a median line. In addition the upper labials in *punctatus* are usually 8, instead of 7 as in *stictogenys.* There is no invariable distinction from *edwardsii.* The general sum of the ventral and caudal scutes is less than 191 in *punctatus* and from 190 to 228 in *edwardsii.* The median row of spots on the belly and the spotted chin are usually distinctive of *punctatus.*

Scutellation.—The scutellation, based upon 115 specimens, is as follows: ventrals 127 to 155 (males 127-150, av. 137; females 134-155, av. 144) ; caudals 34 to 56, (males 43-56, av. 47; females 34-50, av. 41) ;

upper labials 8, occasionally 7; lower labials 8, occasionally 7 or 9; preoculars 2, sometimes 1 or 3, rarely none; postoculars 2, rarely 1; temporals 1+1, sometimes 1+2; posterior chin shields in contact, shorter than the anterior; males commonly with anal ridges on dorsal scales near vent, females without; scale rows nearly always 15 throughout (one 15-14, one 15-17-15, and one 15-14-15) .

Form ane Size. The body is nearly cylindrical, a little wider at the temples and tapering a little toward the tail. The latter varies from .143 to .242 of the total length (males .193-.242, av. .215; females .143-.210, av. .180) . The largest specimen examined measured 367 mm. and was a male from Augusta, Georgia. The largest specimens from Florida measured 307 mm. and were a male from Lemon City and a female from Fort Myers. The total length of all specimens examined are shown in Fig. 22.

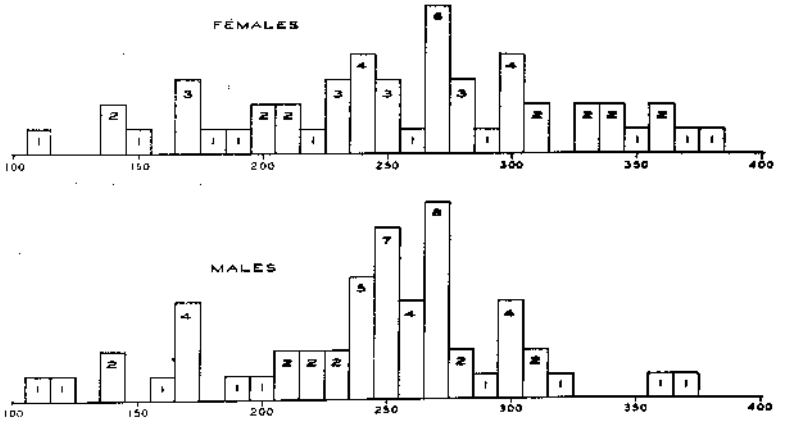


Fig. 22. Distribution by size (total length to nearest 10 mm.) and sex of 103 specimens of *D. p. punctatus.*

Coloration. The coloration above is light brown to nearly black, extending onto the ends of the ventrals, each scale more or less minutely mottled with a lighter color; a yellow neck ring one-half to two scales wide (commonly about one scale wide) is always present, but frequently partially or completely interrupted on the middorsal line; the ventral surface is yellowish to deep brick red, with a median series of large half-circular black spots, convex anteriorly, on the posterior edges of the ventrals; dark spots on the ends of the ventrals often extend from one-third to one-half the distance to the midventral spots; the head is dark

above; the labials and chin are typically speckled with black. In some specimens the dark color of the head extends around the angle of the jaw and forward a little, as in *arnyi.*

The colors of a living specimen of moderate size (MZUM 60900) from Marion County, Florida, were determined as follows: dorsal scales black, minutely mottled with Olive Brown, giving the general effect of a Chaetura Black, or a little darker; head above black with fine, irregular markings of Olive Brown, the black extending without lighter markings onto the upper fourth to half of the upper labials, then replaced abruptly by a pale Yellow-Orange; a black lengthwise dash on the fifth and sixth upper labials; lower labials pale Yellow-Orange except for irregular black spots; chin and gular scales with a deeper orange; belly anteriorly Cadmium Yellow, changing gradually posteriorly to Brazil Red under the tail; on the ventral scales a series of black spots along the median line, and a posterolateral series on each side, the latter slightly mottled like the dorsal scales; neck ring Salmon-Orange above, becoming lighter on the sides.

The colors of a living juvenile specimen from Hallandale, Florida (USNM 42852) , were determined by Stejneger as follows: upper side Clove Brown; under side Cadmium Orange, fading to lighter on chin and darkening into Orange Chrome under tail ; collar Cadmium Orange.

Dentition. The following dentition is revealed by the examination of a small series of specimens: maxillary teeth 15 to 20, commonly 16, the last two of which are distinctly larger, or twice as large, and separated from the rest by a distinct interspace, or by no interspace; mandibular teeth 22 or 23.

HABITAT AND HABITS

Considering that this species has been known for more than a century and a half it is not flattering to naturalists that no worth while observations on its life history and habitat were made until 1915. In this year Wright and Bishop (p. 153) published their notes on three specimens secured in the Okefinokee Swamp in southern Georgia, as follows: "This attractive snake was found during the day under cover, usually under logs near the cypress edges of Billy's Island. It seemed to prefer localities near the edge of the thicker woods. In one case it was found under a log" . . . . close to the "thick, swampy cypress edge of Billy's Island," where, however, "the vegetation was of the pine-barren type. . . . In the other instance the two were taken (June 11, 1912)

under a log near Billy's Island landing at the woody edge of cultivated fields." One of these specimens "had six unlaid eggs which measured as follows: 18x9 mm., 19x9, 19x9, 20x9, 20x9, 21x10. The covering is thin and quite pinkish in alcohol. .. . These specimens had insect and worm remains in their alimentary tracts."

Dr. H. P. Löding, a collector of much experience in Alabama, states (1922, p. 27) that it is found "under logs and sphagnum moss in moist places." Since Löding did not distinguish this form from *stictogenys,* his remarks may refer to either or both. Two specimens (MZUM 56331-2) were collected April 19, 1921, near Enterprise, Florida, by J. H. Williamson, under an old rotten chunkin damp ground about six feet from a lake, Gleason's Pond, but only a few inches above the water level. The soil in the vicinity was sandy. Corrington (1929, p. 70) found it only in the piedmont region near Columbia, South Carolina; he reports it as "cryptozoic by day and roving by sundown."

DISTRIBUTION

Range.—This form occurs in North Carolina, South Carolina, and Georgia, except in their mountainous parts, throughout Florida, and in southeastern Alabama as far as Mobile Bay (Map 4, page 68) . In the western parts of the first three states it intergrades with *edwardsii,* and, in Alabama, with *stictogenys* . It also occurs in eastern Virginia. A specimen from Matawan, Monmouth County, New Jersey, has been included in the list of specimens because it can not properly be identified in any other way than as *punctatus.* The coastal plain from North Carolina to Long Island should be searched for ring-neck snakes to settle the question of the extent of the ranges of *punctatus* and *edwardsii in* this region. *

MATERIAL EXAMINED

ALABAMA: *Autauga Co.*—Autaugaville, USNM 52451. *Baldwin Co.*—*ALA (1). Conecuh Co.*—near Sepulga River, below Herbert, ALA (1), *Lee* Co.—Auburn, CORNELL 1022.

FLORIDA: MCZ 4838; ANSP 12138. *Alachua* Co.—Gainesville, AMNH 3684, MCZ 6588, 16301, USNM 14108, FNB (1). *Brevard* Co.—Canaveral Light, AMNH 6979; Eau Gallie, MCZ 7025; Georgiana, USNM 11984 (6), 13667, 13702, 13705; Melbourne, USNM 71052; E. Peninsula, opposite Micco, AMNH 3683. *Broward* Co.—Fort Lauderdale, MCZ 18085-6; Hallandale, USNM 42859. *Citrus* Co.—Arlington, MCZ 4422. *Col*

32087, 36576-80, 38163-4; Miami, USNM 26338; Paradise Key, MCZ 20286-7. *Hernando* Co.—Brooksville, USNM 55328. *Indian River* Co.—Sebastian, MCZ 18082-4.

* [Recently reported from New Jersey by Trapido (1937, p. 14) and from Maryland by McCauley (1941, p. 55).]

Lake Co.—Eustis, USNM 24360; Leesburg, FNB (3). *Lee* Co.—Fort Myers, AMNH (1), USNM 36706. *Manatee* Co.—Anna Marie Key, USNM 82108; Bradenton, USNM 72389. *Marion Co.*-ANSP 12021, MZUM 60900; Candler, MZUM 52391. *Orange Co.*—Orlando, USNM 23808. *Palm Beach Co.*—West Palm Beach, MCZ 13889. *Pinellas Co.*--Clearwater, USNM 10585. *Sarasota Co.*—Osprey, USNM 31952. *Volusia* Co.—Enterprise, ANSP 4831, MZUM 56331-2; Maytown, MCZ 20298.

GEORGIA: MCZ 277 (3), 278; USNM 9110. *Berrien* Co.—Alapaha, USNM 13474. *Bibb Co.*—Macon, MZUM 61625. *Charlton Co.*—Billy's Island, Okefinokee Swamp, CORNELL 6104-6. *Chatham Co.*—Savannah, USNM 5016. *Chattahoochie Co.*—Fort Benning, USNM 80946-7. *Elbert Co.*—Huguenot, USNM 27744. *Fulton Co.*—Rosswell, MCZ 258. *Liberty Co.*— Riceboro, FMNH 2033. *Richmond* Co.—Augusta, USNM 8794.

NEW JERSEY: *Monmouth* Co.—Matawan, AMNH 43895.

NORTH CAROLINA: *Catawba Co.*—Hickory, MCZ 4310. *Harnett Co.*—Summerville, USNM 1881 *(2)*. *New Honover Co.*—Wilmington, USNM 9115, 26076. *Wake Co.*—Raleigh, FMNH 4293, 4296-7, 4569, MZUM 58813-8, USNM 56458.

SOUTH CAROLINA: *Anderson Co.* —Anderson, USNM 1895, 20630-1. *Charleston Co.* —Charleston, MCZ 381. *Lexington Co.*—Leesville, FNB 266, 269. *Sumter Co.*—Congaree River Swamp, near Sumter, NYM (1).

VIRGINIA: *Nansemond Co.* —Cypress Chapel, FNB (1).

In addition to the localities in the list of specimens examined, the following records have been published:

FLORIDA: *Duval Co.*—Jacksonville, Deckert (1918, p. 32). *Orange Co.*-Opopka, Lönnberg (1894, p. 325). *Pinellas Co.*—Tarpon Springs; *St. James Co.*—Hastings, Brimley (1910, p. 1 3) . [Reported from the following additional counties by Carr (1940, p. 78) : *Escambia, Liberty, Leon, Sumter, Hillsborough, Osceola, Highlands, Charlotte,* and *Monroe.]*

[MARYLAND: *Worcester Co.*—Pokomoke State Forest and Berlin, Mc Cauley (1941, p. 55).]

[NEW JERSEY: *Ocean Co.*--Lakewood, Trapido (1937, p. 14).]

NORTH CAROLINA: *Craven Co.*—Brimley (1909, p. 134). *[Durham* and *Orange* Cos.—Gray (1941, p. 656).]

SOUTH CAROLINA, *Charleston Co.*—Mount Pleasant; *Dorcheiter Co.*---Summerville, Schmidt, (1924, p. 68) . *[Georgetow n Co.*—Jopson (1940, p, *42) .]* *Richland Co.*—Columbia, Corrington (1929, p. 70) .

VARIATION

The material for the study of this subject consists of about 50 specimens of each sex. Scant though this is, it is yet sufficient to bring out clearly some interesting points.

There is no significant difference in the extreme or average numbers of ventrals between southern Florida and northern Florida (Table VIII) but in the northern part of the range of *punctatus* the extremes and averages are distinctly higher. Reference to the accompanying table shows

that the ventrals average more by 5 in North Carolina than in the peninsula of Florida, and this number is increased by 5 more in west-central Alabama. The average for North Carolina would be higher but for one exceptional specimen with only 127 ventrals (the next lowest has 139). Scattered specimens from Georgia indicate that here, too, the number of ventrals is greater than in Florida.

Table VIII. Geographic Variation in Number of Ventrals and Caudals in *D. p. punctatus.*

	Ventrals						Caudals					
	Males			Females			Males			Females		
Region	No.	Extremes	Average	No.	Extremes	Average	No.	Extremes	Average	No.	Extremes	Average
Southern Florida	13	130-140	134	10	138-148	142	13	44-53	48	13	39-45	41
Northern Florida	18	127-139	133	12	134-149	143	18	43-50	46	12	36-41	38
Florida and Southern Georgia	34	127-147	135	27	134-153	142	34	43-53	47	29	36-55	40
North Carolina	12	127-145	140	4	146-150	149	12	42-54	49	4	38-47	44
West-central Alabama intergrades	12	135-153	145	19	148-163	154	11	46-55	50	16	38-48	43
Whole Range	52	127-150	136	44	134-154	144	52	42-55	47	45	36-53	41

The figures for geographic variation in number of caudals and proportionate length of tail are not consistent enough to be convincing. The indication is that the tail is a little shorter in northern Florida and a little longer in southern Florida and in northern parts of the range (Table IX) .

The upper labials are more constantly 8 in Florida and southern Georgia than in other parts of the range (Table X) . In these states six specimens have 7 on one side and 8 on the other; two have 7 on both sides; all the others, 59 in number, have eight on both sides. One from the Okefinokee Swamp in southern Georgia has 7 on both sides. For the range as a whole, 9 specimens have 7 on both sides, 16 have 7 on one side and 8 on the other, and 77 have 8 on both sides. The relative number of individuals of these first two groups would be decidedly higher if all parts of the range were equally represented in the collections.

The neck ring is more constantly interrupted in Florida than in other parts of the range and the figures of Table XI suggest that this feature may be more frequent in southern Florida than in the northern part of the state. For Florida and southern Georgia the number of specimens at hand with neck rings not interrupted is 13, while the number having the ring partly or completely interrupted is 49. For North Carolina these

figures are, respectively, 6 and 7, and for the series of intergrades from west-central Alabama, they are 28 and 3 (two of the latter have the ring only partly interrupted) . The neck ring averages narrower in Florida (½ to 1 scale length in width) , a little wider in Georgia (1 to 1½ scale lengths), and still wider in North Carolina (1 to 2 scale lengths) . In

Table IX. Geographic Variation in Proportionate Tail Length in *D. p. punctatus.*

Region	*Males*			*Females*		
	No.	*Extremes*	*Average*	*No.*	*Extremes*	*Average*
Southern Florida	10	.204-.238	.220	10	.171-.191	.181
Northern Florida	18	.193-.228	.212	9	.143-.193	.176
Florida and Southern Georgia	31	.193-.238	.215	24	.143-.193	.178
North Carolina	11	.204-.232	.216	4	.176-.200	.190
Whole Range	46	.193-.238	.215	35	.143-.200	.181

Table X. Geographic Variation in Number of Upper Labials in *D. p. punctatus.*

Region	7 - 7	7 - 8 or 8 - 7	8 - 8
Florida and Southern Georgia	2	6	59
North Carolina	1	5	8
Whole Range	9	16	77
West-central Alabama intergrades	8	3	18

Table XI. Geographic Variation in the Neck Ring in *D. p. punctatus.*

Region	*Not interrupted*	*Partly interrupted*	*Completely interrupted*
Southern Florida	5	8	13
Northern Florida	8	3	20
Florida and Southern Georiga	13	13	36
North Carolina	6	4	3
Whole Range	28	20	43

west-central Alabama it is generally less than one scale length wide. The variations in the neck ring are in no way correlated with sex.

The markings of the under surface show distinct geographic variation. The ventral series of median spots are larger, as a rule, in Florida and more constant in form and more clean-cut in outline. Here, too, the chin is almost constantly spotted with black. In North Carolina the ventral spots are usually smaller and are often missing from the anterior scutes. The chin is more often immaculate than spotted. Specimens from the Okefinokee Swamp show great variability. In one (CORNELL 6104) the ventral spots are smaller than average, have indistinct outlines, and are discontinuous at several points, both anteriorly and posteriorly. In another the spots are very large and well developed. In a third (CORNELL 6102) the spots are of average size and shape. In a fourth (CORNELL 6106) the spots are more elongate laterally than usual. All of these specimens have spotted chins. In general we may say that the maculation of the lower surface is more constant and typical in Florida, more variable in the western part of the range, and more reduced in the northern.

Variation with sex is conspicuous in the number of ventrals and caudals and in proportionate length of tail. If the number of caudals be subtracted from the number of ventrals the following rule holds true in 98 per cent of the specimens: males 79 to 97; females 98 to 115. This accuracy is almost equaled by the rule for determination of sex on the basis of proportionate tail length. If the tail length divided by total length is .200 or less the individual is a female; if it is .201 or more it is a male. The accuracy of this rule is nearly 97 per cent. This is, of course, applicable only to individuals with uninjured tails.

Anal ridges are characteristic of adult males but relatively few specimens of this form were examined for this character.

Among the minor variations may be mentioned the occasional presence of 9 or 7 instead of 8 lower labials; 2 instead of 1 posterior temporal; 1 instead of 2 postoculars; 1, 3, or none instead of 2 preoculars; a single instance each of scale formulas 15-14, 15-14-15, and 15-17-15; two cases of the division of the preanal plate; and two instances in which a few anterior caudals were not divided. It is unlikely that any of these variations are of geographic significance.

[A small albino specimen has been reported by Neill (1941, p. 266) from Augusta, Georgia.]

AFFINITIES

The preceding discussion of variation has brought out the fact that *punctatus* is most uniformly distinct in the most isolated portion of its range, Florida. To this region we may add, on the basis of specimens at hand, the Atlantic coastal plain as far north as southern North Carolina. How far west along the Gulf Coast this area of uniformity extends, there are, at present, no specimens in collections to show. The preceding discussion has likewise demonstrated that *punctatus* varies on the west toward *stictogenys.* Specimens from the northwestern part of the range show not only *stictogenys* characters in their narrow neck rings, variable ventral markings, and frequently 7 upper labials, but *edwardsii* characters in their high number of ventrals and rarely interrupted neck rings. These specimens are intermediate between three races in their characters as well as in their geographic position. *Punctatus* shows approach to *edwardsii* not only in North Carolina but all along the southern and southeastern border of the range of the latter form.

In short, the closest relatives of *punctatus* are unquestionably the two forms closest to it geographically, *stictogenys* and *edwardsii.*

Diadophis punctatus edwardsii (Merrem)

Eastern Ring-neck Snake; Ringed Snake; Fodder Snake

Fig. 23

1802. *Coluber torquatus* SHAW,* Gen. Zool., vol. 3, pt. 2, p. 553 (based upon Edward's Gleanings Nat. Hist., vol. 3, 1764, p. 290, pl. 349).

1818. *Coluber punctatus* SAY, Amer. Journ. Sci., vol. 1, no. 3, p. 261.-SMITH, Geol. Mass., ed. 1, 1833, p. 552; ed. 2, 1835, p. 534.-KIRTLAND, Second Ann. Rep. Geol. Surv. Ohio, 1838, p. 167, 188.—STORER, Rept. Mass., 1839, p. 225. -DE KAY, Zool. New York, pt. 3, 1842, p. 39, pl. 14, fig. 29.—THOMPSON, Hist. Vermont, 1842, p. 117.—LINDSLEY, Amer. Journ. Sci., vol. 46, 1844, p. 42.—HOUGH, Fifth Ann. Rep. N. Y. St. Cab. Nat. Hist., 1852, p. 23. JONES, Nova Scotia Inst. Sci., 1865, p. 5. — *Calamaria punctata* SCHLEGEL, Essai Phys. Serp., 1837, p. 39.— *Diadophis punctatus* BAIRD AND GIRARD, Cat. N. Amer. Rep., 1853, p. 112.—BAIRD, Serp. New York, 1854, p. 7, 24; Pac. R. R. Surv., vol. 10, 1859, Rept. pl. 33, fig. 82s, 82u.—COPE, Proc. Acad. Nat. Sci. Philadelphia, 1860, p. 250.—MILES, First Bien. Rep. Geol. Surv. Mich., pt. 2, 1861, p. 233.—Foot, Proc. Portland Soc. Nat. Hist., vol. 1, 1862, p. 86. -VERRILL, Proc. Boston Soc. Nat. Hist., vol. 9, 1863, p. 197.—ABBOTT, Geol. New Jersey, 1868, p. 801.---ALLEN, Proc. Boston Soc. Nat. Hist., 1868, p. 182;

**Coluber torquatus* Shaw is preoccupied by *Coluber torquatus* Lacépède = *Natrix natrix* (Linnaeus).

idem, 1870, p. 262.-JORDAN, Man. Vert., 1876, p. 179.-SMITH, Suppl. Sci. News, vol. 7, 1879, p. 7.-NEILSON, Rept. Staten Island, N. Y., 1881, p. 1.-BICKNELL, Trans. Linn. Soc. N. Y., vol. 1, 1882, p. 123.-SMITH, Geol. Surv. Ohio, vol. 4, 1882, p. 696.-GARMAN, S., Mem. Mus. Comp. Zool., vol. 8, no. 3, 1883, p. 72, 158, pl. 2, *fig.* 2.-HAY, Hort. Rep. *St.* Ind., 1884-5, p. 9.-HUGHES, Bull. Brookville Soc. Nat. Hist., no. 2, 1886, p. 42.-HIGLEY, Trans. Wis. Acad. Sci., vol. 7 (1883-7), 1889, p. 166, 174.-NELSON, Final Rep. St. Geol. New Jersey, vol. 2, 1890, p. 646.-BLATCHLEY, Journ. Cincinnati Soc. Nat. Hist., vol. 4, 1891, p. 32.-COPE, Proc. U. S. Nat. Mus., vol. 14, 1892, p. 614, 617.-HAY, 17th Ann. Rep. Dept. Geol. Nat. Res. Ind. (1891), 1892, p. 492.-ABBOTT, Nat. Ramb. about Home, 1894, p. 301, 476.-DITMARS, Proc. Linn. Soc. N. Y., no. 8, 1896, p. 13.-MAC KAY, Proc. Nova Scotia Inst. Sci., vol. 9 (1895-6), 1897, p. 41; *idem,* 1898, p. xli, xliii.-MEARNS, Bull. Amer. Mus. Nat. Hist., vol. 10, 1898, p. 326.-PIERS, Proc. and Trans. Nova Scotia Inst. Nat. Sci., vol. 9, 1898, p. 181.-BLATCHLEY, 24th Ann. Rep. Geol. Nat. Res. Ind., 1899, p. 545, 551.-COPE, Ann. Rep. U. S. Nat. Mus. (1898), 1900, p. 751, *fig.* 162.-ATKINSON, Ann. Carnegie Mus., vol. 1, 1901, p. 148.-BROWN, Proc. Acad. Nat. Sci. Philadelphia, 1901, p. 69.-ECKEL, Amer. Nat., vol. 35, 1901, p. 152.-MORSE, Ohio Nat., vol. 1. no. 8, 1901, p. 127.-ECKEL AND PAULMIER, Bull. N. Y. St. Mus., no. 51, 1902, p. 367.-HAY, Proc. Biol. Soc. Washington, 1902, p. 135.-BRITCHER, Proc. Onondaga Acad. Sci., vol. 1, 1903, p. 122.-CLARK, Fourth Ann. Rep. Mich. Acad. Sci., 1904, p. 193.-HENSHAW, Occ.. Papers Boston Soc. Nat. Hist., no. 7, 1904, p. 6.-MORSE, Ohio St. Univ. Bull., sera 8, no. 18, 1904, p. 126.-DITMARS, Amer. Mus. Journ., vol. 5, no. 3, 1905, p. 99, *fig.* 6.-DROWNE, Roger Williams Park Mus. Monog. no. 15, 1905, p. 9.-GIBBS, NOTESTEIN, AND CLARK, Seventh Rep. Mich. Acad. Sci., 1905, p. 110.-NOTESTEIN, Seventh Rep. Mich. Acad. Sci., 1905, p. 119.-RUTHVEN, Rep. Mich. St. Bd. Geol. Surv. (1905), 1906, p. 111.-STONE, Amer. Nat., vol. 40, 1906, p. 166.-SURFACE, Bull. Div. Zool. Penn. St. Dept. Agric., vol. 4, no. 4 and 5, 1906, p. 171.-FOWLER, Ann. Rep. N. J. St. Mus., pt. 2, 1907, p. 165, text *fig.* 1, pl. 40.-HAHN, Proc. U. S. Nat. Mus., vol. 35, 1908, p. 564.-NASH, Vert. Ontario, Rept. Batr., 1908, p. 13.-REED AND WRIGHT, Proc. Amer. Philos. Soc., vol. 48, no. 193, 1909, p. 406.-RICKETSON, Proc. Thoreau Mus. Nat. Hist., vol. 1, 1911, p. 12 . -ENGLEHARDT, Mus . News, Brooklyn Inst. Arts, Sci., vol. 8, no. 8, 1913, p. 129-FAULL, Nat. Hist. Toronto Region, Canad. Inst., 1913, p. 240.-WRIGHT AND ALLEN, Field Note Book of Fishes, etc., 1913.-DUNN, Copeia, no. 18, 1915, p. 6; *idem,* no. 25, 1915, p. 63.-ENGLEHARDT *et al.,* Copeia, no. 17, 1915, p. 2.-LATHAM, Copeia, no. 25, 1915, p. 61.-DUNN, Bull. Amer. Mus. Nat. Hist., vol. 37, 1917, p. 630.-FOWLER, Copeia, no. 40, 1917, p. 15.-GAIGE, Copeia, no. 39, 1917, p. 7.-MATTERN, Copeia, no. 46, 1917, p. 65.-STEJNEGER AND BARBOUR, Check List, 1917, p. 76.-DECKERT, Copeia, no. 54, 1918, p. 32.-DUNN, Copeia, no. 53, 1918, p. 27.-WRIGHT, Copeia, no. 67, 1919, p. 10.-CONGER, Michigan Vert., Mich. Agric. Col., 1920, p. 43.-WAGNER, Copeia. no. 108, 1922, p. 54. -BISHOP, Copeia, no. 125, 1923, p. 117.-FOWLER, Copeia, no. 145, 1925, p. 63; *idem,* no. 146, 1925, p. 66.-FUNKHOUSER, Wild Life in Kentucky, 1925, p. 121.-DITMARS, Bull. N. Y. Zool. Soc., vol. 32, no. 3, 1929, p. 86, 107, fig. 1.-STEWART, Reptiles of Pennsylvania, 1929, p. 5.-*Ablabes punctatus* GUNTHER, Cat. Colubrid Snakes Brit.

Mus., 1858, p. *28-29.-Coronella punctata* BOULENGER, Cat. Snakes Brit. Mus., vol. 2, 1894, p. 206.-BOETTGER, Kat. Rept. Samml. Mus. Frankfurt am Main, pt. 2, 1898, p. *72.-Diadophis punctata* RUTHVEN, Thirteenth Ann. Rep. Mich. Acad. Sci., 1911, p. 1 l 4.-JACKSON, Science, n. s., vol. 39, 1914, p. 534. -Elms, Nineteenth Ann. Rep. Mich. Acad. Sci., 1917, p. 49.

1820. *Coluber edwardsii* MERREM, Tent. Syst. Amph., p. 136 (Type locality Pennsylvania; William Bartram, collector) .

1860. *Diadophis punctatus pallidus* COPE, Proc. Acad. Nat. Sci. Philadelphia, p. 250 (Type locality California;* type specimen ANSP 3468; Dr. Heerman, collector) -DUMÉRIL AND BOCOURT, Miss. Sci. Mex., pt. 3, 1866, p. 621.

1875. *Diadophis punctatus punctatus* COPE, Bull. U. S. Nat. Mus., no. 1, p. 37, 85. -YARROW, Bull. U. S. Nat. Mus., no. 24, 1882, p. 15, 95.-DAVIS AND RICE, Ill. St. Lab. Nat. Hist., Bull. 5, 1883, p. 35; Bull. Chicago Acad. Sci., vol. 1, no. 3, 1883, p. 29.-YARROW, Smiths. Misc. Coll., no. 517, 1883, p. 15.

1891. *Diadophis punctatus amabilis* BLATCHLEY, Journ. Cincinnati Soc. Nat. Hist., vol. 14, p. 32.

1919. *Diadophis punctatus edwardsii* BARBOUR, Proc. N. Eng. Zool. Club, vol. 7, p. 9.-DUNN, Proc. Biol. Soc. Washington, vol. 33, 1920, p. 136.-ORTENBURGER, Copeia, no. 99, 1921, p. 75.-BLANCHARD, Occ. Papers Mus. Zool. Univ. Mich., no. 117, 1922, p. 9.-STEJNEGER AND BARBOUR, Check List, ed. 2, 1923, p. 83.-BREDER AND BREDER, Zoologica, vol. 4, 1923, p. 21.-LANGLOIS, Papers Mich. Acad. Sci., Arts, Let. vol. 4 (1924), 1925, pt. 1, p. 605.-BLANCHARD, Papers Mich. Acad. Sci., Arts, Let., vol. 4 (1924), 1925, pt. 2, p. 34, *fig.* 78; *idem*, vol. 5 (1925), 1926, p. 382.-BRIMLEY, Jour. Elisha Mitchell Sci. Soc., vol. 42, no. 1 and 2, 1926, p. 86.-SCHMIDT, F. J. W., Copeia, no. 154, 1926, p. 132. -BISHOP, N. Y. St. Mus. Hdbk. no. 3, 1927, p. 78, fig. 2.--BLANCHARD, Papers Mich. Acad. Sci. Arts, Let., vol. 7 (1926), 1927, p. 279-292, pl. 13-19, *fig.* 1-18.-BISHOP, Journ. Elisha Mitchell Sci. Soc., vol. 43, no. 3 and 4, 1928, p. 167.-BLANCHARD, Copeia, no. 167, 1 9 2 8, p. 47.-BROWN, Canad. Field Nat., vol. 42, 1928, no. 5, p. 126.-POPE, Bull. Milwaukee Pub. Mus. , vol. 8, 1928, p. 49, *fig.* 9, 10.-RUTHVEN, THOMPSON AND GAIGE, Mich. Hdbk. Sera, no. 3, 1928, p. *72, fig.* 21, 22, pl. 1, 9, 10.-VAN CLEAVE, Trans. Ill. St. Acad. Sci., vol. 20, 1928, p. 134, table 2.-CAHN, Copeia, no. 170, 1929, p. 6.-JORDAN, Man. Vert. Animals, ed. 13, 1929, p. 236, *fig.* 5.-LOG-

Antivenin Inst. Amer., vol. 4, 1930, no. 1, p. 4-10, *fig.* 1-7.-MYERS, Copeia, no. 173, 1930, p. 101.-BLANCHARD, Bull. Antivenin Inst. Amer., vol. 4, 1931, no. 4, p. 99, *fig.* 7.-PLATT, Proc. Ind. Acad. Sci., vol. 40, 1931, p. 362.-DURY, Proc. Jun. Soc. Nat. Sci. Cincinnati, vol. 3, 1932, no. 2, p. 25.-STEJNEGER AND BARBOUR, Check List, ed. 3, 1933, 1). 90.-CONANT AND BAILEY, Occ. Papers Mus. Zool. Univ. Mich., no. 328, 1936, p. 5.-STEJNEGER AND BARBOUR, Check List, ed. 4, 1939, p. 99.

*The type locality of *D. punctatus pallidus* is undoubtedly erroneous. The specimen is a *D. p. edwardsii*. Its scale rows are 15-15 except for 16 or 17 rows irregularly for a short space near the forward end; ventrals 156; caudals 60; upper and lower labials 8; preoculars and postoculars 2; temporals 1+1; neck ring two scale lengths in width; no ventral spots; total length 405 mm.; tail 77 mm.; sex male.

DESCRIPTION

Diagnosis.—The distinctive features of *edwardsii* are the generally unspotted belly and chin, uninterrupted neck ring, 15 rows of scales throughout the body length, 8 upper labials, and a high average number of ventrals (usually from about 145 to 170). The most constant distinctions from *punctatus* are the unspotted belly and chin, and the sum of ventrals and caudals lying between 190 and 228. When spots do occur on the belly in this subspecies they are smaller and more irregular in form than in *punctatus* and they are usually in an interrupted line.

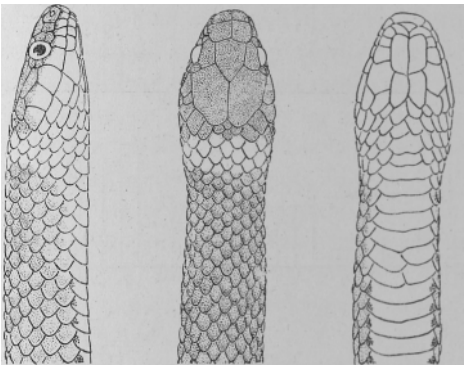


Fig. 23. *D. p. edwardsii,* MZUM 60908, Emmett County, Michigan.

Scutellation.—Examination of over 900 specimens reveals the following scutellation: ventrals 139 to 176 (males 139-162, av. 151; females 146-176, av. 160); caudals 41 to 65 (males 48-65, av. 57; females 41-61, av. 51) (Table II, p. 20); upper labials 8, occasionally 7, rarely 6 or 9; lower labials 8, occasionally 7, rarely 6 or 9; preoculars 2, rarely 1 or 3, in a single instance 4; postoculars 2, rarely 1, in single examples 3 and 0; temporals 1+1, rarely 1+2, more rarely 2+1; posterior chin shields in contact, parallel to each other, and shorter than or about as long as the anterior chin shields; loreal rather large and nearly square; dorsal scale rows nearly always 15 throughout body length, but formulas of 15-14, 13-15, 13-15-14, and 13-13 have each been found once.

Proportions and Length.—The body of this form is less slender in proportion to its length than that of the western races. The snout is nearly truncate in outline, viewed from above; the eyes are small; the head is distinctly flattened above, and widest near the posterior angle of the mouth, tapering from this point to the beginning of the general body

width just back of the neck ring. The body maintains a nearly uniform width to near the vent. The tail tapers to a horny tip, more gradually in males, more suddenly in females. It varies from .152 to .261 of the total length (males .188-.261, av. .231; females .152-.226, av. .200) (Table II, p. 20) .

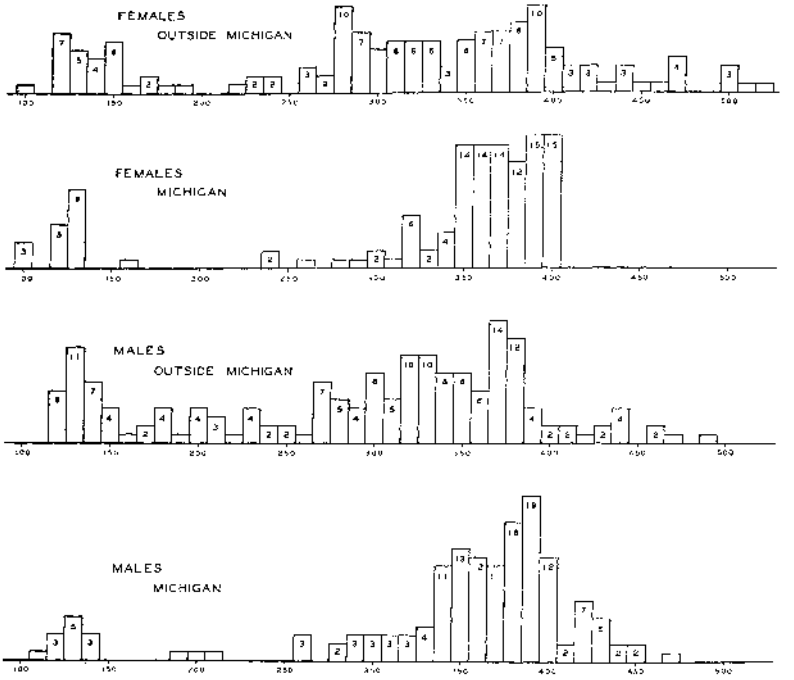


Fig. 24. Distribution by size (total length to nearest 10 mm.) and sex of 583 specimens of *D. p. edwardsii.*

The young at hatching measure ordinarily from about 110 to 135 mm. in length. In proportions they are not noticeably different from the adults. The males are sexually mature at about 280 mm., and from this length on most individuals possess small but definite anal ridges. The females are probably not often mature when shorter than 300 mm. in length, and they are ordinarily not mature until they have attained a length of about 340 mm. Anal ridges are nearly always lacking in females (Blanchard, 1931, p. 99) . The greater number of specimens collected have been adults varying in size up to a little over 500 mm. The mean length of a large series of adult males from northern Michigan was found to be 357 mm., while the mean length of a similar series

of adult females proved to be 365 mm. Since the difference between these means is only twice the probable error of the difference, it can not be assumed that these figures indicate any significant difference in size between the sexes in this subspecies (Blanchard, *loc. cit.)*. The largest specimen seen by the writer was a female 517 mm. in length, that came from Bristol, West Virginia. The largest male measurcd 494 mm., and came from Huntingdon County, Pennsylvania. The smallest specimen measured was only 84 mm. in length. Total lengths in this subspecies are summarized in Figure 24.

Color and Pattern.--The general color above is bluish slate to nearly gray and this color extends over all the dorsal scales except for a band of orange or yellow close behind the head from three-fourths of a scale wide to three scales in width. The top of the head is a little darker, and the neck ring is bordered behind with this darker shade. The black of the head extends down on the sides as far as the upper border of the rostral and upper labials. The color below is some shade of yellow or orange. Typically there are no dark spots on chin, belly, or under the tail, but an interrupted line of small black spots is not infrequently present along the middle of the belly; very rarely these are as well developed as in *punctatus.* Occasional specimens show a few spots on the chin. Sometimes, also, a few minute dark specks are scattered on the ventral plates, but they are rarely noticeable.

Actual colors of a living specimen from Augusta County, Virginia, are dark smoky gray above, top of head olive, collar orange-buff, underside deep chrome, fading to cream-color on throat. A specimen from the Beaver Islands in Lake Michigan was nearly glossy dark Neutral Gray above, the neck ring and belly were Light Ochraceous-buff to Ochraceous-orange, the belly lighter anteriorly and deeper posteriorly.

Dentition. The maxillary teeth (counted on 29 jaws) are commonly 17 or 18 on each side, although numbers of 16 and 19 are not infrequent and as few as 15 have been found. The last two teeth are but little or not at all larger and are separated from the rest by only a very short interspace. The other kinds of teeth were counted in only a few specimens. These gave the following figures: mandibular teeth 20 or 21; palatine 10 to 13; pterygoid 20 or 21.

HABITAT

The habitat of this subspecies is in general the deciduous forest of northeastern North America, with which its range nearly coincides. It also occurs in the southern portion of the coniferous forest to the north

It seems to be always found within or near wooded places, and references to its capture most commonly state that it is found under the loose bark of fallen trees or under stones. De Kay (1842, p. 39) refers to it as "very common under the bark coverings of the huts of the frontier settlers." From first-hand observations in Connecticut, Linsley (1844, p. 42) says "they are found under stones and more commonly under large clods in new plowed fields, and sometimes under the bark of decayed trees." Writing for Allegheny County, Pennsylvania, Atkinson (1901, p. 148) says it "is found occasionally in damp or mossy woods." In Allegheny State Park it is reported by Bishop (1927, p. 78) to hide "by day in the shelter of stones and logs or beneath the loose bark of stumps and fallen trees." In southern Michigan the writer collected a female in May from under moss and liverworts on a very punky old stump by a woodland pool. It has been found recently (1930) under logs and stones in, and at the edge of, woods within the township limits of Ann Arbor, Michigan. In the northern portions of the southern peninsula of Michigan more than 300 specimens have been collected within the past ten years. Here they are found under the loose rotted bark of fallen trees, chiefly hemlock, in old logs channeled by insects or decay, under boards or piles of boards that have long lain undisturbed and in old piles of hemlock bark. Many have been found in such places close to and at the edge of the Great Lakes beaches of Emmet and Cheboygan Counties. At the edges of unburned woods in such places they may be found in concealment absorbing the sun's heat.

Ditmars (1907, p. 335) states that these snakes were most frequently found under the bark of trees infested by ants; often the working streams of these insects would pass but a fraction of an inch from the spot where the reptile lay coiled. In one instance he "exhumed one of these snakes while digging through a large and thickly populated ant-hill." This relationship to ants, however, has not been checked by other observers. Although the writer has found ants in the same logs with ring-neck snakes, it has seemed as if the snakes avoided the logs that had the most ants, and only used such logs for the passageways the ants' tunnels afforded, A well-tunneled log allows the snake his choice of a suitable temperature for resting.

HABITS

Time of Activity.

On very few occasions has it been seen in the open in the daytime. Fowler (1907, p. 167) , writing of it in New Jersey, says it "is some-

times met with in forest paths," and Hahn (1908, p. 564) reports seeing it moving about in the daytime. Bishop (1927, p. 78) also reports finding one in the open "crawling in the low herbage covering the top of a large block of conglomerate" at Allegheny State Park in New York. The writer found one in Cheboygan County, Michigan, lying in an open crevice of a fallen rotted log in a wooded ravine, and in a similar situation in southern Indiana a small one was found on the surface of the ground under the overhanging edge of a large rotted log. In an outdoor enclosure for ring-neck snakes, maintained by the writer, an individual has been seen exposed occasionally in the daytime. Langlois (1925, p. 606) noted that specimens in a terrarium "remained in concealment and nearly motionless throughout the daytime, but became active after dark," and this has been the writer's experience repeatedly.

Sociability. There is some evidence of a gregarious tendency in this subspecies. It has been the experience of the writer to find two or three of these snakes in one place about as often as to find only one. Langlois (1925, p. 606) found nine together under a single board in northern Michigan. Lifting of this same board on different days by Dr. Langlois or the writer during the same and many subsequent seasons nearly always revealed at least one or two ring-neck snakes, and in one instance seven at a time. After the board finally rotted thin and a large hole appeared in its middle no more snakes sought refuge under it. A notable case of this apparent sociability was the discovery by the writer of fifteen ring-neck snakes (fourteen males and one young female) in a single small log on the beach of the Straits of Mackinac. The log was completely channeled by ants, and the snakes were scattered through these tunnels. This was on July 2, 1930. This sociable tendency may be assisted by the musk produced by the glands at the base of the tail, but I know of no direct evidence of this. It is probable that the snakes congregate in places that provide agreeable warmth and concealment.

These snakes are rather nervous and do not always take kindly to handling; they may void a little of their brownish musk or even attempt to bite. They will lie quietly, however, if completely covered by the hand, or after they become accustomed to its warmth.

The season of activity for the vicinity of Cayuga Lake, New York, is reported by Reed and Wright (1909, p. 406) as April 19 to October 16.

Food. As to its food, little is definitely known. It is generally said to eat insects and worms, but various writers report the following as actual stomach contents: the red-backed salamander *(Plethodon cinereus),*

beetles, ground beetles, earthworms, a young green snake *(Opheodrys vernalis)* , and an adult red-bellied snake *(Storeria occipito-maculata)* . An adult ring-neck snake has been preserved with a red-bellied snake nearly swallowed (Brooklyn Mus. 340) . Other items of food mentioned by authors, but without evident grounds, are lizards, young mice, toads, birds' eggs, insect larvae, and pupae of large black ants. Their insectivorous propensities, in particular, need verification.

The writer has repeatedly observed them in captivity to take readily the red-backed salamander and he has dissected it on several occasions from the stomachs of wild specimens. Rarely these snakes can be induced to eat earthworms, but in captivity their reactions to worms indicate that they are not a favorite food. Specimens captured in the daytime usually have empty stomachs. The fragments that may remain in stomach and intestine are generally unidentifiable. This suggests early evening as the ordinary feeding time.

[Mc Cauley and East (1940, p. 122) state that a ring-neck snake captured in Garrett County, Maryland, disgorged a "very large *Plethodon glutinosus.* "]

Number of Eggs. The most common number of eggs in a clutch is three, but two and four are also common numbers, while one, five and six are much less common. The total number of records through 1932 for clutches of one to six eggs are, respectively, 4, 23, 40, 35, 18, and 10.

Natural Nests. Most of the natural nests discovered have been in rotted logs that lay exposed to the sun and usually in logs with a shell of unrotted wood on the outside. In such logs the eggs may be found in a cluster in the soft part just under the shell on the sunny side of the log. Often only a single clutch of eggs will be found in one nest, but it is not at all unusual to find more eggs in a nest than a single female could possibly produce. Nests of *7,* 8, 10, 20, and 48 eggs have been observed by the writer and in each of these cases the eggs could be sorted into small groups containing those of similar shapes and proportions. Several other sets of more than six that have been reported in the literature may be assumed to have been composite (Blanchard, 1930, p. 5). That females may in successive seasons resort to favorable logs for deposition of eggs was clearly indicated by the presence, in the nest of 48 eggs mentioned, of numerous egg shells which showed by their state of decay that they belonged to two preceding seasons. Several similar discoveries have been made.

Dates of Egg-laying.—There is much variation in dates of egg-laying in different parts of the range and even in the same locality in different seasons. In northern Michigan the eggs are commonly laid in July: July 2 to 30 for females brought to the laboratory. But in 1930 a nest of 48 eggs was discovered as early as July 2, and in 1932 several nests were found on June 29. These seasons proved early for other animals and for plants as well, and the early laying is probably to be attributed to unusually warm weather in May and June of those years, respectively.

A suspicion that bringing female snakes to the laboratory delays the laying of their eggs received some confirmation from the laying dates of six females that were taken from the log that contained the nest of 48 eggs, found July 2. These females deposited eggs on July 11, 12, 17 (2) , and 19 (2) .

In southern Michigan (Ann Arbor), a female collected June 3, 1930, laid eggs two weeks later and another taken May 30 laid its eggs on June 20. Ditmars records a laying on June 28 (1907, p. 336) for southern New York by a captive specimen.

Deposition of Eggs . During deposition the eggs accumulate in a heap in the midst of a double coil of the snake's body. During the extrusion of the egg the anterior half of the tail is held in an arch sufficiently high to avoid contact with the emerging egg. The latter comes out during a series of fifteen or more muscular movements, the effect of which seems to be, during the early part of the progress of the egg, to squeeze the egg out, and, during the latter part of the process, to pull the anus forward away from the egg. It takes about four or five minutes from the first appearance of the egg in the vent for it to be completely separated therefrom. The average interval between appearances of eggs of a clutch was 38 minutes for twelve cases. The extremes were 22 and 79 minutes.

Description of Eggs. Freshly laid eggs are elongate, straight or curved, with ends blunt or slightly pointed. They are cream-colored with sulphur-yellow ends, or, rarely, they may be yellow all over. The yellow fades gradually until, towards the latter part of the incubation period, it disappears completely. The cream color of the rest of the egg likewise becomes much duller and the surface may become variously stained from contact with external materials.

In length the eggs vary from 20.5 to 41.6 mm. and in width from 6.0 to 10.6 mm., but the great majority lie between 20.5 and 35.0 mm. in length and 6.5 and 8.5 mm. in width. After deposition the eggs swell gradually, the ends become more pointed and the middles irregularly distended. Towards the end of the incubation period they may have increased from 7 to 21 per cent of the original length.

Period from Laying to Hatching. The interval from laying of the egg to emergence of the young snake varies with the temperature. It is greater under ordinary laboratory conditions than in nature. Eggs laid in the laboratory and kept there have hatched in approximately 56 days. In northern Michigan the hatching dates have varied from the last few days of August through the first three weeks of September. It is perhaps fair to assume that in northern Michigan under natural conditions hatching takes place in the latter part of August.

The laying of the eggs may not take place at the same stage of embryonic development in different females, for it has been noted that the eggs laid earliest in the season may not hatch sooner than those laid later. The laying season is, in fact, more prolonged than the hatching season. "The average laying period for four seasons was 17.5 days and the hatching period for the same seasons averaged 9.8 days.

Hatching. The process of hatching is always prolonged for several hours, during which the young snake may lie for long periods with only the tip of its snout showing through a slit in the egg shell. Ordinarily emergence occurs in 15 to 24 hours after the first slit appears in the egg, but the period may occasionally be shorter or longer than this. If much shorter the snake may still be attached to its embryonic membranes and so be unable to get away from the shell even though out of it. An egg-tooth is present and is, presumably, used in cutting the shell. It is shed in a day or two after the snake emerges.

Description of the Young Snakes.—When just out of the egg these little snakes present a beautiful, trim appearance. They are nearly black above, and shiny, with the top of the head still blacker, the neck ring pale orange-yellow, and the belly pinkish and translucent. By comparison with Ridgway's Color Standards, more of the individuals examined were Slate Color than any other color. Variations extended from dark Plumbeous to Plumbeous-black, and dark Neutral Gray to Slate-black. The neck ring was most commonly Maize-yellow, but varied to Orange-buff on the one hand and to Ivory-yellow on the other. The belly color, because of translucency, was variable on each individual. Its general color range was from pale Salmon to Flesh-ocher.

In a few days the belly becomes opaque and buffy in color. The upper surfaces become gradually duller and on about the eighth or ninth day the skin is shed. The interval before shedding has been noted to vary from 5 to 16 days. Whatever may be the cause of this variation, it appears that snakes of a clutch tend to shed their skins after about the same interval.

After shedding, the young snakes are even improved in appearance. The color above is velvety black, with the top of the head still blacker, the neck ring a brighter yellow or orange-yellow, and the belly shiny cinnamon or buff. In terms of Ridgway's Color Standards, the dorsal coloration of most of the specimens was Slate-black, but varied to dark Neutral Gray and Plumbeous Black. The neck ring varied from Apricot-yellow to deep Chrome on the one hand and to Baryta-yellow on the other. The lower surfaces were commonly about Clay Color with variations to Zinc-orange and Buckthorn-brown.

Activities of the Young Snakes. The little snakes climb and explore about rather actively. It is a question what their food in nature may be. They have showed no interest in earthworms, sowbugs, crickets, caterpillars, beetle larvae, small bugs, ants, ant pupae, ant larvae, spiders, and slugs. A small, year-old, red-backed salamander *(Plethodon cinereus)* excited immediate interest and one snake ate it. This was repeated in two instances, and one young snake ate the writhing, separated tail of an adult *Plethodon.* A small newt failed to excite interest.

A fuller account of many of these topics on habits, and a paragraph on abnormalities, may be found in the author's two articles on the habits of this species (1927, p. 279; 1930, p. 4) .

RANGE

The eastern ring-neck snake is known to occur from Wisconsin to Nova Scotia and south through the Appalachian Highlands. The details of its distribution are shown on Map 4 (p. 68) .

The northernmost known portion of its range is in the upper peninsula of Michigan, but it very likely ranges even farther north. It should be looked for in northern Minnesota. It has been found on Hog Island, in the Beaver Island group in the northern part of Lake Michigan; Bois Blanc Island, in the northern end of Lake Huron; Washington Island (Door County), Wisconsin; La Have Island, near Halifax; Mount Desert Island, Maine; Nantucket, Massachusetts; and Long Island, New York. The extreme southern Appalachians in northern Georgia and northeastern Alabama should be explored for this species.

It has been said by several authors to occur throughout Illinois but specimens from only two localities in Illinois are available to substantiate this. The probability is that it occurs in suitable places over most of the state, but *arnyi* has been taken at points along the Mississippi River and it is likely that *stictogenys* occurs in the extreme south. (See remarks on this subject under *arnyi,* p. 85-86) . For Tennessee there are but few

records. This is a region of much interest, for in western Tennessee *stictogenys* is found and in north central Alabama the population is intermediate between *edwardsii, stictogenys,* and *punctatus.* In the coastal plain region of Georgia, South Carolina, and North Carolina, the race of ring-neck snakes that occurs is *punctatus.* It is a question how far north this subspecies ranges. A specimen of *punctatus* that, according to G. P. Englehardt, comes "without question" from Yaphank, Long Island (Brooklyn Mus. 940) , requires that collectors take particular note of ring-neck snakes on Long Island. All other specimens from this region of which the writer has record are typically *edwardsii,* and for this reason it would seem best to regard this unexpected specimen as mislabeled. The question seems, however, to be distinctly reopened by a *punctatus* from Matawan, Monmouth County, New Jersey, collected May 28, 1911, by W. DeW. Miller (AMNH 43895) . Other ring-neck snakes taken in New Jersey come from farther west and northwest and often show a rather definite trend toward *punctatus* in a low number of ventrals and partially developed ventral spotting. It may develop that both subspecies inhabit New Jersey, *punctatus* the eastern and southern portion, *edwardsii* the northwestern. In this case *punctatus* will be found in the Delaware-Maryland peninsula and eastern Virginia.

That the ring-neck snake is more common in some parts of its range than in others is to be expected from what has been said above about its habitat. It is now much more rare in those parts of its range that have been most extensively deforested and cultivated. Due to its secretive habits the most careful searching may be necessary to prove its presence in a given region.

MATERIAL EXAMINED

CANADA. NOVA SCOTIA: *Lunnenburg* Co.—La Have Island, CGS 139; Moose Hill Landing, near Liverpool, USNM 81830. ONTARIO: Camp Otter, CORNELL 6296 (2) ; Devil's Island, Lake Timagami, FNB (1) ; *Lincoln Co.* —St. Catherines, USNM 52488. *Muskoka* Co.--Bracebridge, cos 76. *York W. Co.* —Toronto, CGS 158. QUEBEC: Meach Lake, COS 124.

CONNECTICUT: AMNH 3694. *Litchfield* Co.—Pleasant Valley, BROOKLYN 1214. *Middlesex* Co.—Middletown, USNM 9666.

DISTRICT OF COLUMBIA: USNM 13296, 43673; Rock Creek Park, USNM 49997; Washington, USNM 60597.

GEORGIA: MCZ 278. *Muscogee* Co.—Columbus, USNM 2154 (2) (Locality and number thought by Dr. Stejneger and the writer to be erroneous).

ILLINOIS: "Southern Illinois," USNM 1967 (2). *Mason* Co.-----Havana, CAHN (2). *Union* Co.—Alto Pass, CAHN (1).

INDIANA: *Clark* Co.-Charleston Landing, MCZ 14137. *Crawford Co.*--MCZ 14139. *Grant* Co.-Sims, USNM 33844. *Jefferson* Co.-North Madison, MCZ 14140. *Lawrence* Co.-Donaldson's Cave, Mitchell, MZUM 61002. *Marion Co.*-14141. *Monroe* Co.-Bloomington, MZUM 61001. *Putnam* Co.--MCZ 14142. *Shelby* Co.-Waldron, CBS 681. *Vanderburg Co. -7 mi.* sw. of Evansville, MZUM 55400, Perry Twp., MZUM 61000. *Vigo Co.*--MCZ 14138.

KENTUCKY: *Bell* Co.-Pine Mountain, near Pineville, ULMZ 1049. *Breathitt* Co.-MCZ 4685. *Edmonson* Co.-Mammoth Cave, MCZ 3511, 3513, AMNH 9630; Mammoth Cave Nat. Park, KU 19194. *Hart* Co.-Horse Cave, USNM 79390. *Rockcastle Co.*-1 mi. NW. of Livingston, USNM 87317. *Whitley* Co.-6 mi. sw. of Corbin, USNM 87320.

MAINE: *Franklin* Co.-Phillips, BSNH 111. *Hancock Co.*-Mt. Desert, BSNH 646. *Kennebec* Co.-Gilman Brook, Monmouth, USNM 36337; Waterville, MCZ 3472.

MARYLAND: *Allegheny* Co.-ANSP 3459. *Montgomery* Co.-Cabin John Creek, FNB (1) ; Forest Glen, USNM 38377; Glen Echo, FNB (1), USNM 62009; Great Falls, FNB (1); Woodside, USNM 25268-70, 52488. *Prince Georges Co.*-Berwyn, USNM 32102; 3 mi. N. of Hyattsville, USNM 52489. *Worcester Co.*--Berlin, USNM 75262.

MASSACHUSETTS: *Barnstable* Co.-Cotuit, MCZ 7017. *Bristol Co.*-*Taunton,* BSNH 705, 715. *Essex Co:* MCZ 745 (4) ; Lawrence, MCZ 246. *Hampden* Co.-Chicopee, MCZ 747; Springfield, MCZ 5610. *Hampshire Co.-Ware,* MCZ 748. *Middlesex* Co.-Hudson, MCZ 2378, 2381; Sherborn, MCZ 12783; Waltham, MCZ 127 (2). *Nantucket* Co.--Nantucket, ANSP 10797. *Norfolk Co.*-Blue Hill, MCZ 12784; Cohasset, BSNH 949. *Worcester* Co.-Berlin, MCZ 744 (2).

MICHIGAN: *Cheboygan* Co.--Bois Blanc Island, Burt Lake, Douglas Lake, FNB ;* MZUM 42144, 52342, 54063. *Charlevoix Co.*-Hog Island, FNB. *Crawford* Co.-Grayling, FNB. *Emmet Co.*-Bay View, MZUM 42819, FNB; Big Stone Bay, FNB. *Jackson* CO.-FNB, MZUM 44554. *Lake CO. : FNB. Livingston Co:* Iosco Twp., FNB. *Marquette* Co.--Ishpeming, FNB; Marquette, MZUM 46932, FNB. *Oakland* Co.--Pine Lake, FNB. *Ontonagon* Co.-Ontonagon, FNB. *Schoolcraft* Co.-FNB. *Washtenaw Co.*-Ann Arbor, FNB, MZUM 43929, 43933.

NEW HAMPSHIRE: *Cheshire* Co.-Dublin, USNM 22813. *Grafton Co.*-Holderness, FNB.

NEW JERSEY: ANSP 3448. *Bergen* Co.-Demarest, AMNH 5151. *Hudson* Co.-Jersey City, AMNH 3685. *Middlesex* Co.-Spotswood, AMNH 43910. *Morris* Co.-ANSP 3447; Lake Hopatcong, AMNH 58078; Newfoundland, AMNH 6458-60, 43904. *Somerset* Co.-Somerville, AMNH 43938; Watchung, AMNH 7736, 14156-8. *Sussex* Co.-Mashipacong Lake, ANSP 16180. *Union* Co.-Berkeley Heights, AMNH 43937; Plainfield, AMNH 43929-31; Scotch Plains, ANSP 19318.

NEW YORK: Indian Ladder, NYM 129. Long Island, AMNH 3697. New York State, BROOKLYN 640. *Cattaraugus Co.*--AMNH 46867. *Essex* Co.-Westport, USNM 1900; Allegheny State Park, FNB. *Franklin Co.*-Tupper Lake, MCZ 7094, 11049. *Fulton* Co.--Johnstown, NYM 130. *Kings Co.*-New Lots, AMNH 3687. *Madison* Co.-Peterboro, USNM 28359. *Oneida* Co.-Waterville, AMNH 3696; White Lakes, NYM 97, 130. *Orange Co.*-Greenwood Lake, AMNH 6709; Hyland Falls, USNM 23327; Palisades Interstate Park, 7 mi. E. of Tuxedo, AMNH 24946-8. *Suffolk* Co.--Miller's Place (10 mi. N. of Yaphank) BROOKLYN (1) ;

*[Michigan localities followed by FNB are represented by from one *to* many specimens in Dr. Blanchard's collection in which the specimens were not given individual numbers.]

Mt. Sinai, AMNH 4155; Yaphank, BROOKLYN 940. *Sullivan* Co.-Fallsburg, MCZ 2471 (3). *Tompkins* Co.-Ithaca, CORNELL 6279, 6301, 7009, 7216-22, KU 55, 3714, MCZ 8895, USNM 50675. *Warren* Co.-Harrisburg, USNM 82558. *Wayne* Co.-North Rose, Sodus Bay, USNM 48545.

NORTH CAROLINA: *Avery* Co.-Linville, AMNH 8418-9, MCZ 13097-8, USNM 85520-2; Pineola, AMNH 8412-5. *Buncombe* Co.-Blue Ridge, MCZ 2275; Flat Creek, near Montreat, USNM 50044; 1-2 mi. SW. of Swannanoa, FNB (4) ; 7 mi. N. of Swannanoa, FNB (1) . *Caldwell* Co.-Mortimer, AMNH 8426. *Guilford* Co.-Guilford, MZUM 52092. *Haywood* Co.-Sunburst, BRIMLEY (3) . *Henderson* Co.-Pink Beds, AMNH 8398. *Macon* Co.-Highlands, CLEMSON 80, 117; 11 mi. w. of Franklin, USNM 87319. *Swain* Co.-East side Wayah (Nantahala) Gap, NYM (1) ; between Swain and Emma, NYM (1) . *Transylvania* Co.-Blantyre, USNM 38222-4; Brevard, AMNH 8407-11; 2 mi. SE. of Brevard, AMNH 8407; Pisgah Forest, MZUM 52673; Rosman, CLEMSON 221. *Watauga* Co.-Blowing Rock, BROOKLYN 449. *Wilkes* Co.-Wilkesboro, BROOKLYN 448.

OHIO: *Adams* Co.-Green Twp., OSM 78. *Ashtabula* Co.-Monroe Twp., OSM 215; Pymatuning Swamp, TZS 1646; Rock Creek, OSM 204. *Butler Co.*-Hughes, USNM 10086. *Clermont* Co.-Union Twp., TZS 1965. *Cuyahoga Co.*-Cleveland, USNM 1899. *Erie* Co.-Sandusky Bay, MZUM 52070. *Fairfield Co.*--Sugar Grove, OSM 2-3, 183. *Greene* Co.-Yellow Springs, MCZ 746. *Hocking* Co.-Clear Creek, OSM 79,80, 172 (2) ; Conkle's Hollow, OSM 358; Good Hope Twp., TZS 297, 1058-9; Salt Creek Twp., TZS 971-6, OSM 300, 338. *Knox Co.*-Edlam, OSM 190. *Meigs* Co.-Pomeroy, OSM 233. *Morgan* Co.-Malta Twp., OSM 373. *Ottawa* Co.-Danbury Twp., FNB; Catawba Twp., FNB. *Pickaway* Co.-Hargus Run, near Circleville, OSM 255. *Pike* Co.-Sunfish Twp., FNB. *Ross* Co.-Colerain, Harrison, and Huntington Twps., FNB. *Scioto* Co.--Morgan Twp., FNB. *Summit* Co.-Ira, OSM 77, 292. *Trumbull* Co.-Kinsman, USNM 60024; Vernon Twp., TZS 334, 1012. *Vinton Co.--1* mi. w. of Allensville, TZS 294-6; Harrison Twp., TZS 980-2, 1166. *Washington* Co.---Marietta, USNM 7286.

PENNSYLVANIA: *Allegheny* Co.-CM 1397-9, 1400, 1901; Carnot, CM 1900; Heights Run, CM 1551; Ingomar, CM 2685; Moon Twp., CM 1574; Natrona, CM 1618; Pittsburgh, CM 1401, 1405-8, 1901, USNM 1890; Tarentum, CM 1411; Wilkinsburg, CM 1899; Wilmerding, CM 1571-2. *Clinton* Co.-Haneyville, CM 1350-3. *Cumberland* Co.-Carlisle, USNM 1880; Pine Grove Iron Works, ANSP 3956. *Fayette* Co.-Bidwell, CM 2041. *Fulton* Co.-Burnt Cabins, CM 4431-2. *Indiana* Co.-Cherry Tree, CM 1662. *Lancaster* Co.-Columbia, ANSP 4007. *Luzerne* Co.-Harvey's Lake, ANSP 16643; Watertown, CM 1365-6. *Lycoming* Co.-Williamsport, CM 1327-8. *Monroe Co.-7* mi. E. of Cresco, ANSP 3954-5. *Northumberland* Co.-Northumberland, FNB ; Susquehanna River, CM 1267. *Philadelphia* Co.-Chestnut Hill, near Philadelphia, ANSP 14727; Fairmont Park, Philadelphia, ANSP 18348. *Potter* Co.-4 mi. S. of Keating Summit, USNM 34589. *Somerset* Co.-Jennerstown, CM 779. *Westmoreland Co.*-CM 1898; Hillside, CM 1089; Laughlintown, CM 1768; Ligonier, CM 4470-1.

RHODE ISLAND: *Newport* Co.-Newport, USNM 9125; Port Ode, USNM 28672-3.

SOUTH CAROLINA: *Oconee* Co.-Clemson College, CLEMSON 51, 217; Russell, CLEMSON 220. *Pickens* Co.-Rocky Bottom, CLEMSON 83, 119, 175-7, 179.

TENNESSEE: *Blount* Co.-Cades Cove, ANSP 13296. *Campbell* Co.---1 mi. NE. of La Follette, USNM 87318. *Cumberland* Co.-15 mi. w. of Crossville, FNB (5). *Sullivan* Co.-19 mi. E. of Bristol, USNM 85519. *Sumner* Co.-Tyree Springs, USNM 1969.

VERMONT: *Bennington* Co.—Pownal, AMNH 3683, 3695. *Lamoille Co.* Stowe, BROOKLYN 937-8.

VIRGINIA: *Albemarle* Co.—Albarene, USNM 24045. *Alexandria Co.*—Alexandria, USNM 54098. *Arlington* Co.—Ballston, USNM 26318. *Augusta Co.* O'Connell's Farm, USNM 36718, 36775; Stribbling Springs, USNM 36739, 36781. *Bedford* Co.--Peaks of Otter, USNM 36707. *Clarke Co.*—White Horse, USNM 52473-4. *Culpeper* Co.—Culpeper, MCZ 2476. *Fairfax* Co.—Fairfax, USNM 44546, 50020; Great Falls, USNM 55414, 61768; 3 mi. N. of Great Falls, FNB; Mouth of Difficult Run, USNM 62065; Mount Vernon, USNM 19793, 38196. *Page* Co.—Stony Man Mountain, USNM 31631. *Shenandoah* Co.—Orkney Springs, USNM 48530-1.

WEST VIRGINIA: *Calhoun [?]* Co.—Big Spring Run, USNM 43190. *Harrison Co.—Bristol,* FNB (3) .

WISCONSIN: *Clark* Co.—Worden Twp., AMNH 17083. *Door Co.*--Ellison Bay, WISC.U. 4063; Washington Island, WISC.U. 2153. *Oneida Co.*—Rhinelander, WISC.U. 1902.

In addition to the preceding, records that appear to be reliable are as follows:

CANADA. NOVA SCOTIA: *Digby-Annapolis* Co.—Annapolis, Jones (1865, p. 5) . *Halifax Co.*—Pine Hill, near Halifax [?], MacKay (1896, p. xli) . ONTARIO: *Welland* Co.—Chippeway, Gunther (1858, p. 28-29). *Wentworth* Co.—Hamilton, Brown (1928, p. 126).

CONNECTICUT: *Fairfield* Co.—Darien; *Hartford Co.*—*New Haven Co.*—Northford, Linsley (1844, p. 42). *Middlesex Co.*—Middletown, Cope (1900, p. 753) .

DELAWARE: Günther (1858, p. 28-29).

ILLINOIS: *Wabash* Co.—Mount Carmel, Cope (1900, p. 753).

INDIANA: *Franklin* Co.—Hughes (1886, p. 42). *Jefferson Co.*—Dury (1932, p. 25) . *Morgan* Co.—Piatt (1931, p. 363). *Montgomery Co.; Parke Co.*—Shades of Death; *Posey Co.*—New Harmony, Hay (1892, p. 493). *[Brown, Martin* and *Morgan Counties,* Swanson (1939, p. 684).]

KENTUCKY: *Franklin* Co.—Frankfort, Funkhouser (1925, p. 121). *Powell* Co.--Natural Bridge St. Park, Clay.* *[Rowan* Co.—Welter and Carr (1939, p. 129).]

MARYLAND: *Anne Arundel* Co.—South River; *Garrett* Co.—Jennings, Fowler (1925, p. 63). *[Cecil* Co.—Elk Neck; *Worcester* Co.—Bishopville and Centerville, McCauley (1941, p. 55).]

MASSACHUSETTS: *Middlesex* Co.—Concord, Ricketson (1911, p. 12).

MICHIGAN: *Eaton* Co.—Clark (1904, p. 193). [Reported from the following additional counties by Ruthven, Thompson, and Gaige (1928, p. 73) : *Gratiot, Kalamazoo, Mackinac, Montcalm, Otsego,* and *Van Buren.]*

[MINNESOTA: *Lake* Co.—Lax Lake, Breckenridge (1942, p. 128).]

NEW JERSEY: *Bergen* Co.—Fort Lee, Ditmars (1896, p. 13). *Mercer Co.* (1868, p. 801) . *Sussex* Co.—Dickertown, Myers (1930, p. 101). *Warren* Co.--Abbott (1868, p. 801) .

*W. M. Clay, *in litt.*

NEW YORK: *Albany* Co.—Bishop (1923, p. 117) ; Slingerlands, Bishop.* *Cattaragus* Co.—Elco Mountain, Frecks, Quaker Run, Red House, Red House Valley, Rock City, Bishop.* *Columbia* Co.—Lebanon Springs, Baird and Girard (1853, p. 113) . *Delaware* Co.—Stamford, Bishop.* *Dutchess* Co.—Fishkill, Eckel and Paulmier (1902, p. 367). *Fulton* Co.—Bishop.* *Greene* Co.—Catskill Mts., Bicknell (1882, p. 123) ; New Baltimore, Bishop.* *Herkimer* Co.—Beaver River, Bishop.* *Onondaga* Co.—Britcher (1903, p. 122) . *Rensselaer Co.*—Eagle Mills, East Greenbush, Sand Lake, Bishop.* *Richmond* Co.—Staten Island, Bishop.* *Rockland* Co.—Palisades Interstate Park, Myers (1930, p. 101) . *St. Lawrence* Co.—Rossie, Hough (1852, p. 23) . *Suffolk* Co.—Cold Spring Harbor, Eckel and Paulmier (1902, p. 367) ; Orient, Latham (1915, p. 61) ; Port Jefferson, Englehardt, *et al.* (1915, p. 2) .

NORTH CAROLINA: *Ashe* Co.—Breder and Breder (1923, p. 21) . [*Swain* Co.—Great Smoky Mts. Nat. Park, King (1939, p. 571) .]

OHIO: *Fairfield* Co.—Sugar Grove, Morse (1901, p. 127) . *Hamilton* Co.—Morse (1904, p. 126) . *Hocking* Co.—Good Hope Twp., Walker.* [Also recorded from the following additional counties by Conant (1938, p. 39) : *Ashland, Athens, Franklin, Highland, Lucas, Monroe, Muskingum, Tuscarawas, Warren,* and *Wayne.*

PENNSYLVANIA: *Clarion* Co.—Foxburg, and *Crawford* Co.—French Creek, Baird and Girard (1853, p. 113) . *Lehigh* Co.—Slatedale, Mattern and Mattern (1917, p. 65) . [*Wyoming Counties,* Dutch Mountain, Conant (1942, p. 163) .] Also reported from the following additional counties by Surface (1906, p. 172) : *Adams* (Cooktown) ; *Beaver* (Beaver) ; *Bedford* (Bedford) ; *Berks* (Tulpehocken) ; *Blair* (Bushman) ; *Bradford* (Wyalusing) ; *Cambria* (Ebensburg) ; *Chester* (Elverson) ; *Clearfield* (Irvona) ; *Columbia* (Light Street) ; *Franklin* (Mont Alto) ; *Huntingdon* (Aitch, Mapleton Depot) ; *Indiana* (Indiana) ; *Jefferson* (Brockwayville) ; *Lackawanna* (Chinchilla) ; *Lawrence* (New Castle) ; *Lehigh* (Walberts) ; *Lycoming* (Williamsport) ; *Perry* (Marsh Run, Duncannon) ; *Snyder* (Beaver Springs) ; *Somerset* (Crumb) ; *Sullivan* (Nordmont) ; *Washington* (Cannonsburg) .

SOUTH CAROLINA: *Greenville* Co.—Greenville, Pickens (1927, p. 111).

[TENNESSEE: *Blount* and *Sevier Counties,* Great Smoky Mts. Nat. Park, King (1939, p. 571) .]

VIRGINIA: *Augusta* Co.—Deerfield, Fowler (1925, p. 66) .

[WEST VIRGINIA: *Randolph* Co.—Elkins, Green (1937, p. 115) .]

WISCONSIN: *Bay field, Clark, Door,* and *Oneida Counties,* Pope and Dickinson (1928, p. 49) . [*Pierce* Co.—Maiden Rock, Breckenridge (1942, p. 128) .] *Wausheka* Co.—Cahn (1929, p. 6) . Boettger (1898, p. 72) reports a specimen from Milwaukee. Although this locality may be correct, it is without verification, and is more likely only the place from which the specimen was sent.

*S. C. Bishop, *in litt.*

C. F. Walker, *in litt.*

VARIATION

It is generally easy to recognize *edwardsii* by means of its numerous differences from the other subspecies in the *punctatus* group. There is significant variation, however, in several features, each of which will be discussed separately.

Coloration. The immaculate character of its lower surfaces is perhaps its most conspicuous characteristic. This is most constant on the chin and anterior portion of the body. When spots are present they are generally posterior in position, small, in an interrupted series, and often with irregular outlines. Furthermore, it is far commoner for these spots to be in a median series than to be scattered; i.e., they resemble *punctatus* in their distribution rather than *arnyi* or *stictogenys.* Although spots may be present on the underside of the body in any part of the range of *edwardsii,* they are uncommon in some parts of the range and common in others. They are often present on specimens from western North Carolina, the vicinity of the District of Columbia, New Jersey, southern New York, Long Island, southern Indiana, and Wisconsin, and they have been noted on a number of specimens from northern Michigan.

The neck ring is generally broad, about two scale-lengths, or a little less, in width, and uninterrupted. It is more commonly narrow in North Carolina than anywhere else. Here it may be as narrow as one-half the length of one scale. In Virginia and southern Indiana it is frequently only one scale-length wide. In more northern portions of the range it is distinctly uncommon to find so narrow a neck ring. The ring is apparently more often interrupted in the southern part of the range than in the northern. Only fifteen instances of interruption of the neck ring have been found in the 900 specimens examined. They are distributed as follows: Massachusetts 1; southern Indiana 1; Ithaca, New York 1; southern New York 4; Michigan 1; New Jersey 3; West Virginia 1; Virginia 1; Pennsylvania 2; North Carolina 1; Georgia 1. Seven additional specimens from scattered localities have partly interrupted neck rings.

Ventrals and Caudals.—As in other forms of *Diadophis* the numbers of these scutes vary definitely with the sex and, since the sex with fewer ventrals (male) has more caudals and the one with more ventrals (female) has fewer caudals, by subtracting the caudals from the ventrals the sexes are more clearly separated (Fig. 25) . This difference, which may be abbreviated V - C, varies from 84 to 106 in males and from 95 to 125 in females. But in most of the males V - C is 102 or less and among

most of the females it is 103 or more. In fact 95 per cent of 594 specimens are in agreement with this rule. This variation in V - C is probably about the same in all parts of the range of *edwardsii*, for a check of this character on 300 specimens from a limited locality in northern Michigan gave less than 3 per cent closer adherence to this rule than a like number of specimens from all other parts of the range (96.1 against 93.4

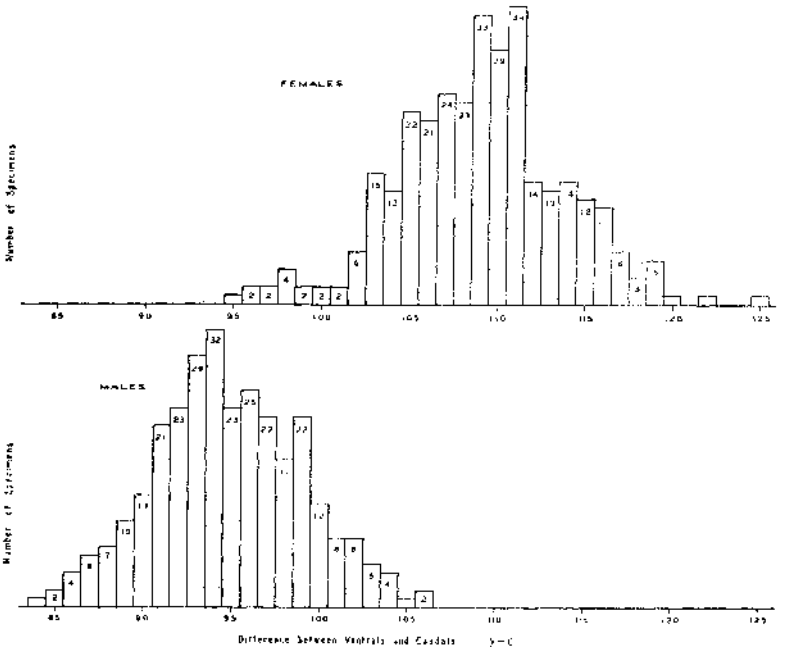


Fig. 25. Comparison of the difference between the numbers of ventrals and numbers of caudals (V-C) in the two sexes in *D. p. edwardsii.*

per cent, Table XII) . In checking the sex by this rule, only specimens with perfect tails may be used. It sometimes happens that a tail tip is regenerated after a loss, so perfectly that it is difficult to distinguish it from an uninjured tail. If such injuries could invariably be detected and if no errors were ever made in determining sex, in counting scales, or in measuring, it is likely that adherence to the above defined rule would be better than 95 per cent.

Table XII. Correlation between Sex and Difference between Numbers of Ventrals and Caudals in *D. p. edwardsii*.

Locality	Difference between ventrals and caudals 102 or less		103 or more		Percentage of agreement with rule
	Males	Females	Males	Females	
Michigan	144	5	7	160	96.1
Elsewhere	158	5	14	132	93.4
Summary	302	10	21	292	94.8

The total number of ventrals and caudals is approximately the same in the males as in the females, as pointed out some time ago by Barbour (1919, p. 8) . Counts of considerable numbers of specimens, however, show this sum to be on the whole a little greater in females than in males. The closest correspondence between the sexes in this character appears to be in the eastern part of the range, the most divergence in the west. A summary for localities whence fair series of specimens were available is given in Table XIII.

The ventrals and caudals, taken separately, show but little variation from one part of the range of *edwardsii* to another. Lower numbers appear to prevail in localities adjacent to the range of *punctatus.* These counts are summarized in Table XIII, p. 122.

Relative Length of Tail. The length of the tail in relation to the total length of the snake varies from .152 to .261 but there is a marked difference in this feature between the sexes. In males the tail is usually more than .217 of the total length and in females it is usually less than .217. Of 217 specimens of *edwardsii* from northern Michigan, all measured alive and by the same person, 95.4 conformed to this rule: in this series no male had a tail less than .209 of his length and only one female (.230) had a tail greater than .220 of her length. Here, too, perfect tails only may be considered. Contrary, perhaps, to expectation, it makes little difference whether the snake is measured alive, freshly killed, or preserved.

The relative length of the tail is rather constant throughout the range of the subspecies, as the geographic summary in Table XIV reveals. The somewhat lower averages for southern Indiana suggest *arnyi* and may be of significance, but they are based upon only a few measurements.

Table XIII. Geographic Summary of Ventrals and Caudals in *D. p. edwardsii*.

Region	Ventrals						Caudals						Sum of ventrals and caudals	
	Males			Females			Males			Females				
	No.	Extremes	Av.	No.	Extremes	Av.	No.	Extremes	Av.	No.	Extremes	Av.	Males	Females
Washington, D. C.	15	145-157	151	12	154-165	159	14	49-63	57	10	46-51	49	209	208
Northern New Jersey	10	141-154	149	10	147-161	154	10	48-64	57	10	42-56	47	206	201
North Carolina mountains	19	146-161	153	17	151-168	159	19	52-62	58	17	47-58	52	211	211
Virginia mountains	7	146-158	153	10	155-170	160	6	54-65	58	9	48-55	52	211	212
Pennsylvania	28	147-157	151	26	148-176	157	25	48-61	56	24	41-60	51	207	208
Central New York	11	150-159	155	10	155-165	159	11	53-64	58	9	48-58	53	213	212
New England	23	145-157	152	10	149-164	159	19	52-65	57	8	48-55	51	209	210
Ohio	15	142-159	150	14	146-165	159	14	50-63	57	13	49-58	52	207	211
Michigan	164	142-162	150	173	149-169	161	127	46-64	56	154	41-61	50	206	211
Southern Indiana	11	139-160	150	8	148-164	154	11	48-57	53	8	44-54	51	203	205
Other Localities	33	139-159	150	25	152-169	161	31	49-64	57	24	44-59	52	207	213
Summary	336	139-162	150.5	315	146-176	159.8	287	46-65	56.5	286	41-61	50.8	207	210.6

Table XIV. Geographic Summary of Relative Tail Length (i.e., tail length divided by total length) in *D. p. edwardsii.*

Region	Males			Females		
	No.	*Extremes*	*Average*	*No.*	*Extremes*	*Average*
Washington, D. C.	10	.203-.246	.230	11	.177-.202	.188
Northern New Jersey	9	.198-.248	.234	10	.164-.215	.196
North Carolina mountains	19	.219-.261	.236	16	.189-.222	.205
Virginia mountains	6	.209-.250	.232	8	.192-.210	.202
Pennsylvania	24	.204-.259	.230	22	.152-.226	.201
Central New York	11	.217-.250	.230	8	.160-.224	.199
New England	19	.206-.248	.230	8	.188-.215	.203
Ohio	13	.188-.247	.225	14	.185-.212	.201
Michigan	90	.209-.261	.233	127	.160-.220	.200
Southern Indiana	11	.200-.245	.218	6	.177-.211	.193
Other localities	27	.204-.252	.230	26	.175-.218	.202
Summary	239	.188-.261	.231	256	.152-.226	.200

Labials. — The upper labials are typically 8, as in *punctatus*, but variation to 7 is common, and sporadic cases of 6 and 9 have been observed (Table XV) . Eight upper labials is most constant in the Applachian Mountain region. In fact, throughout most of the range of *edwardsii* two-thirds of all specimens have 8 upper labials on each side of the head, but in Michigan and Indiana only 41 per cent are like this. Here 34 per cent have seven on both sides while in the east only 14 per cent have seven on both sides. This difference between the eastern and western portions of the range seems, however, not to be correlated with any other characters to a noteworthy extent.

The lower labials are 8 on both sides in 71 per cent of all specimens examined. Most of the other specimens vary to 7, although several snakes had b or 9. The summary of the lower labials by localities is given in Table X V 1.

Scale Rows. The number of rows of dorsal scales is 15 throughout the body length in all parts of the range of *edwardsii.* Only two specimens in over 700 examined had more than this number (two males from Ohio, one from Washington County and the other from Vinton County, each with the formula 15-17-15) , but several cases of variation to less than 15 have been found. One from Shenandoah County, Virginia, and another from Middlesex County, New Jersey, had 13 rows for a short

Table XV. Geographic Summary of Numbers of Upper Labials in *D. p. edwardsii.*

Region		*Labial formula* 6-6	6-7 7-6	7-7	7-8 8-7	8-8	8-9 9-8	*Total numbers of specimens*
District of Columbia and vicinity				5	4	18		27
Northern New Jersey			1	4	3	11	1	20
North Carolina mountains				3	5	29		37
Virginia mountains				1	3	14		18
Pennsylvania				7	7	36	2	52
Central New York				3	3	15		21
New England				6	7	23		36
Ohio				4	4	18		26
Michigan		2	2	128	83	154	1	370
Southern Indiana				4	9	6		19
Other localities				8	12	38		58
Summary	Number of specimens	2	3	173	140	362	4	684
	Percentages	0.3	0.4	25.3	20.5	52.9	0.6	100.0

Table XVI. Geographic Summary of Numbers of Lower Labials in *D. p. edwardsii.*

Region		*Labial formula* 6-6	6-7 7-6	7-7	7-8 8-7	8-8	8-9 9-8	9-9	*Total numbers of specimens*
District of Columbia and vicinity				3	4	20	1		28
Northern New Jersey		1		4	3	13			21
North Carolina mountains				1	1	31	1	3	37
Virginia mountains				2		15	1		18
Pennsylvania				1	3	45	2	2	53
Central New York					2	19			21
New England				1	6	28			35
Ohio				1	3	19	2		25
Michigan		7	2	68	63	255	2	2	297
Southern Indiana				1	5	13			19
Other localities			1	6	3	46			56
Summary	Number of specimens	8	3	88	93	504	9	5	710
	Percentages	1.1	0.4	12.4	13.1	71.0	1.3	0.7	100.0

distance anteriorly; one from Springfield, Massachusetts, had 13 at the anterior end of the body and 14 posteriorly; one from Fairfield County, Ohio, had the formula 15-14, one from Turkey Run, Indiana, and another from Vinton County, Ohio, had it 15-13. Several anomalies of this sort have appeared in the large series examined in northern Michigan. Three had formulas of 15-14, one had 15-14-15 (by loss of the median row); one had 13-15, two had 15-13 (irregularly 13 posteriorly) , one had only 13 rows, and another had the formula 15-14-15-13. The odd formulas 15-13, 13-15-14, and mostly 14 throughout appeared in newborn snakes; another little one had only 11 rows along most of its length (Blanchard, 1927, p. 287) . These variations from the norma115-15 formula may, perhaps, be taken as indications of a tendency inherent in this subspecies, and not related to a similar tendency in any other form of *Diadophis.* They cannot be regarded as ancestral reversions because the only other forms in the genus exhibiting this tendency are certain forms of *amabilis,* which cannot with any reason be regarded as ancestral to *edwardsii.*

Oculars. While the oculars are ordinarily 2 in front of the eye and 2 behind, 26 snakes, 4 per cent of the total number examined, have been found with variations from this condition (Table XVII) . The two oculars of a side may be fused, the lower preocular may be united with the

Table XVII. Variation in Oculars, in *D. p. edwardsii.*
(The left figure of a pair refers to the preoculars, the right to the postoculars.)

Left side	*Right side*	*Number of specimens*
1,2	1,2	4
1,2	2,2	2
2,2	1,2	1
2, 2	2, 1	1
2 , 1	2 , 2	3
3,2	2,2	5
2,2	3,2	4
2 , 1	2 , 1	1
3 , 2	3, 2	2
2, 2	4, 2	1
2, 0	2, 2	1
3, 3	1, 3	1

loreal, the upper preocular may be fused with the prefrontal, the lower postocular may be divided to form three postoculars, or the upper postocular may be united with the supraocular or with the parietal.

Temporals.—Behind the postoculars, and between the parietal and the upper labials, there is ordinarily one temporal followed behind by another. Whether significant or not, it is of interest that the variation from this normal is exactly the same as the variation from the normal arrangement of the oculars, i.e. 4 per cent. This variation is commonly by addition of a small scale above the second temporal. Eight snakes had this change on the left side only, four had it on the right only, and eight had it on both sides. Three specimens had two anterior temporals on the right and one had two on the left. An instance of the fusion of the anterior temporal with the sixth upper labial on each side was found and occasional instances of the separation of first and second temporals by the meetings between them of the sixth or seventh upper labial and the parietal scutes have been noted. The posterior temporal is generally followed by a pair of scales, one above the other.

Other Variations. No anal plate has been found undivided in *edwardsii,* but the preanal is subject to variation in shape and is not infrequently divided. It is not uncommon to find one or more caudals entire, instead of divided, and sometimes some of the ventrals are divided. One snake was observed to have two pits on some of the dorsal scales. This may be a more frequent variation, as most specimens were not examined for this feature.

AFFINITIES

Since there can be no question but that the closest relatives of *edwardsii* are the other members of the punctatus group, these latter will be considered in order.

In the discussion of the affinities of *stictogenys* it was shown that this form is much more closely allied with *arnyi* and *punctatus* than with *edwardsii. Stictogenys* possesses no characters in common with *edwardsii* that are not possessed also by *punctatus.*

A comparison of *arnyi* with *edwardsii* brings out (1) a close correspondence in number of ventrals (Table II, p. 20), (2) a similarity in the relatively broad, uninterrupted neck ring, and (3) the fact that the ranges of the two are in contact (Map 4, p. 68) . In connection with these appearances of relationship it should be pointed out that although the numbers of ventral plates in these two forms are much alike, the caudals are much fewer in *arnyi,* and the proportions of body and tail are therefore decidedly different. Furthermore, the uninterrupted neck ring loses significance as *evidence* of relationship between these two forms

from the fact that it is a characteristic of most members of the genus. In addition, details of the head pattern closely connected with the ring in *arnyi* are decidedly different from *edwardsii*. In the former the dark color of the head extends around the angle of the mouth (Fig. 16, p. 71), a feature lacking in *edwardsii* (Fig. 23, p. 105). The last two maxillary teeth in *arnyi* are enlarged, as in the western ring-neck snakes, while in *edwardsii* they are scarcely, if any, larger than those more anterior. In the latter form, also, the minimum number of maxillary teeth is the same as the maximum number in *arnyi*. In spite of these differences between *arnyi* and *edwardsii* it has been shown that their ranges meet and that specimens from the region of contact may be intermediate between the two races.

The two forms left for comparison are *punctatus* and *edwardsii*. These forms are virtually alike in (1) number of upper labials, (2) number of maxillary teeth, (3) scale formula, and (4) proportionate length of body and tail. The first of these characters is particularly significant, since it occurs elsewhere in the genus only in specialized forms in the Pacific Coast states. It links punctatus with *edwardsii* more closely than the possession of some character common to numerous forms of the genus. The number of maxillary teeth and the reduced scale formula are shared in the eastern United States only with *stictogenys*. These characters, too, are specialized and hence significant of close relationship. The fact that the proportionate length of tail and body is almost the same in these two forms, is an important confirmation of the close affinity implied in the first three characters.

Punctatus and *edwardsii* differ in (1) number of ventrals, (2) number of caudals, (3) ventral markings, and (4) width of neck ring. The fact that the first two of these characters differ in the same direction means that they are correlated with the larger size of *edwardsii*. The third and fourth characters, presenting the most decided differences between these two forms, will be considered below.

In connection with the foregoing comparisons of the most constant distinguishing features of the members of the *punctatus* group, it will be of interest to consider the possible meaning of variations in *edwardsii*. (1) Variation to 7 upper labials may be expected from the fact that 7 is the prevalent number in the genus, but 7 in *edwardsii* is most common in the parts of its range lying near to the range of *arnyi*, i. e. in Michigan and Indiana. The evidence of this is, perhaps, not very strong (Table XV), but ring-neck snakes in these two states show a much higher incidence of seven upper labials than they do in eastern parts of the range.

The few specimens known from Wisconsin and Illinois indicate that this tendency is not continued to the western limits of the range of *edwardsii,* where it actually meets the range of *arnyi.* Although this may, conceivably, be due to hybridization of originally distinct forms, or to intergradation of directly related types, or to some other cause, the writer considers it as, on the whole, more likely to be a local geographic reversion. (2) Occasional variation to 2 in the second series of temporals may be regarded as of no significance in this connection because it occurs in all forms of *Diadophis* except in the Mexican form, *dugesii,* where that condition is the rule. (3) Variation to a lower scale formula than 15-15 may be regarded as evidence of an orthogenetic tendency to degeneration. Such formulas are very rare in *stictogenys* and *punctatus* and occur elsewhere in the genus only in west coast forms. (4) Occasional interruption of the neck ring cannot be relied upon as evidence of affinity with *punctatus* because it may occur in almost any form in the genus. (5) The ventral side of the body is ordinarily devoid of markings, but it is by no means unusual to find a median series of black spots particularly on the posterior part of the body. They are usually small and interrupted but occasionally are as well-developed as in *punctatus.* These spots are more often present on specimens from near periphery of the range adjacent to the range of *punctatus,* but they occur in all parts of the range of *edwardsii.* Much more rarely specimens of *edwardsii* exhibit small scattered ventral spots, generally with hazy margins. Such specimens have been noted from West Virginia, from near the District of Columbia, and from southern Ohio. These may be interpreted as atavistic. The rather common occurrence of a more or less marked median series of ventral spots in all parts of the range of *edwardsii* is regarded by the writer as one of the strongest evidences of its derivation from *punctatus.* Although it must be admitted that a ventral pattern like that of *punctatus* is on rare occasions developed in *arnyi,* it would be too much of a strain on all the facts involved to use this as an argument for the close affinity of *edwardsii* with *arnyi.* It is rather an expression of a tendency in the latter that finds its culmination in punctatus by way of *stictogenys.*

It is evident that in this group we have two races that are essentially upland in habitat *(arnyi* and *edwardsii)* and two that are essentially lowland *(stictogenys* and *punctatus)* , and that the upland races are larger species and the lowland races smaller species. Consideration of these facts alone might lead one to the assumption that the genetic relationships are closest between the forms of similiar habitat. The preceding comparison of structural characters does not bear this out for the upland forms. The interpretation here adopted is that *arnyi* was the first eastern form of the

genus and that it has always had its center in the Ozark upland. Spreading to the north and west was limited by a climate and topography that may never have been more congenial to the species than they are at present, and spreading to the northeast was limited by the climate of the glacial period. Since the first opening to its spread was southward, this, the lower Mississippi region, was colonized first. The invaders became altered accompanying their isolation in a new habitat and as a result the subspecies *stictogenys* was established. Whether the habitat was in any way responsible for the general reduction in size of the race can hardly be proved. Spread to the Floridan peninsula from this center gave rise to the well-marked *punctatus*. Here again no cause can be assigned to the fact that the small size was not noticeably altered in this new but still lowland habitat. From this southeastern lowland migration into the Appalachian uplands restored this branch of the genus to its ancestral type of habitat, and, either as a result therefrom, or by chance, or from some other cause, these migrants became altered into a race of larger size. While this increase in size, including increase in numbers of ventrals and caudals, simulated the more remote relative, *arnyi,* it was accompanied by tell-tale resemblances to its more immediate ancestors, characters not possessed by *arnyi.* These characters have already been listed and so need no repetition here.

In summary, evidence has been presented indicating that *arnyi [docilis + arnyi]* is the oldest form in the *punctatus* group, that it has given rise to *stictogenys,* that the latter is ancestral to punctatus, and that punctatus is ancestral to *edwardsii.*

GENERAL SUMMARY OF RELATIONSHIPS

The ring-neck snakes form an obviously natural group ranging over most of North America north of central Mexico. Four separate groups with no overlapping of ranges are clearly recognizable. One group comprises a single species without geographic differentiation into subspecies, so far as now known, *Diadophis dugesii* of Mexico. As explained in the discussion of the affinities of the species (p. 54) its two posterior temporal scutes and the high scale formula, 17-17 and 17-19-17, are important evidence that this is the most primitive living *Diadophis* In addition, its possession of the characters most general in the other races and its lack of specalization as compared with other forms in the genus leave hardly room to doubt its ancestral position.

In the eastern states four closely allied subspecies make up the *punctatus* group. Of these, *docilis [docilis + arnyi]*
and from it the line of evolution appears to have proceded to *stictogenys,*

then to *punctatus* and finally to *edwardsii.* Geographically, this was a spread in something of a circle from the Ozark upland east and south in the lower Mississippi valley, then to the extreme southeastern states, and lastly north through the Appalachian highlands and west in Illinois and Wisconsin to the eastern limits of the range of *arnyi.* Here the two forms *arnyi* and *edwardsii* apparently hybridize in a narrow area.

Structural changes in the course of this evolution in the *punctatus* group began with a 17-rowed race with a high number of ventrals and variously-spotted underparts and ended with a 15-rowed form with no spots at all below. The ventrals were decreased in the two southern races and the spots below were arranged into a midventral line. Then the spots were reduced to absence, the ventrals and caudals were increased in number, and this form *(edwardsii)* became the largest in the eastern group. There were other progressive changes, as detailed in the previous discussions, particularly the reduction in size and increase in number of the posterior maxillary teeth, and the loss of the interspace between the last two and those preceding. The extension of the dark color of the head around the angle of the jaw, so characteristic of *docilis, arnyi,* and *dugesii,* finally disappeared in *edwardsii,* as has likewise the red color under the tail, a feature of *docilis, arnyi,* and all the western races of *Diadophis.* Likewise the chin spotting, slower in reduction, is finally gone in *edwardsii.*

Since this last can only be regarded as a relatively specialized form among the living races of *Diadophis*, the connection of the *punctatus* group with other members of the genus can be only through *docilis.* The closest relative of *docilis* has been shown to be *dugesii,* a form with which its range appears not to be in contact. But even if not in contact and if no intergradation occurs it can hardly be doubted that *docilis* is a nearly or quite direct descendent of *dugesii.*

The two western groups are like each other, and distinct from the Mexican *dugesii* and the other forms of *punctatus* in their high ventral count and the tendency to recession of the dark color from the lower rows of dorsal scales. One representative of each of these western groups may with about equal reason be regarded as closely related to *dugesii: laetus* and *modestus. Laetus* seems a little more distant in its higher number of ventrals and larger size, but its known limits of variation in these respects do not exclude the possibility of intergradation with *dugesii,* for the structural limits of neither of these forms are at all well known. In regard to their geographic limits, there may be an unknown extinct form, or an unknown living annectant race, or the ranges of the two may meet.

However, *laetus* is to be favored as more closely related to *dugesii* than *modestus* because it is geographically nearer. Perhaps the greater frequency of two posterior temporals in *laetus* is significant of a closer affinity with *dugesii.* The other member of the *laetus* group, *regalis,* although it lies north of the range of *dugesii* and may be in contact with it, is best regarded as directly derived from *laetus* by loss of the neck ring as it seems otherwise to be identical with *laetus.*

Laetus is closely connected with the *amabilis* group through *modestus,* which differs from it chiefly in the smaller number of ventrals and caudals and the related character of relative length of tail. These differences could conceivably be bridged by normal variation in the species, but they are not so far as now known, and the ranges of the two are so well separated by inhospitable country that intergradation between them is hardly more to be expected than contact between their ranges.

The other forms of *amabilis* have diverged definitely from the relatively primitive *modestus.* Their evolution, as described in the summary of the *amabilis* group, shows two or three lines of modification. To the south, *similis* was derived from *modestus* by reduction of scale rows from 17-15 to 15-15 and 15-13, [and the insular form, *anthonyi,* from *similis].* To the north *vandenburghi* evolved from *modestus* by recession of the dorsal color on the lower rows of scales, then farther north *occidentalis* was derived by reduction of scale rows to 15-15, and finally the end-form, *pulchellus,* of the Sierra Nevada was differentiated by loss of pigment on the ventral side and on the lower dorsal scale rows, and by a widening of the neck ring.

Amabilis may have come from *vandenburghi* or *occidentalis,* but as shown in the summary of the *amabilis* group (p. 50) it is more probably a derivative from *modestus.* The relationships among all the forms of *Diadophis* are expressed diagramatically in Figure 26.

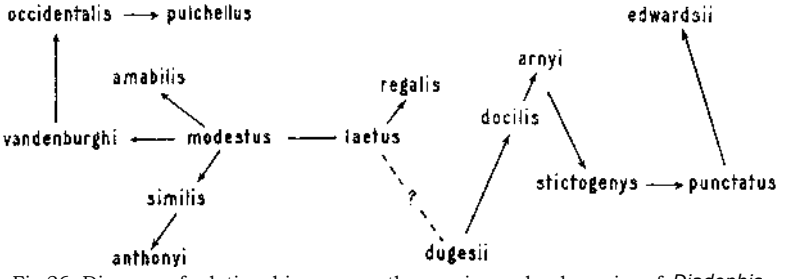


Fig 26. Diagram of relationships among the species and subspecies of *Diadophis.*

We see in the genus *Diadophis* another example of a group of related North American snakes that has differentiated in several directions

from a southwestern center. Change has accompanied spread. All forms retained the early loss of the second posterior temporal scute, a feature presumably related to the flattened head and secretive life. The end forms, east and west, became notably similar in their complete loss of ventral pigmentation and in the end forms, too, the scale rows became the most reduced. The western races acquired very long and slender bodies, the eastern ones notably shorter bodies. The western forms retained the primitive dentition, while the eastern forms increased their maxillary teeth and showed how rear fangs and an interspace could change to the supposably more primitive condition of an uninterrupted line of similar teeth.

The genus as a whole cannot be regarded as exactly modern for there are geographic breaks between the groups and very likely losses of forms there. The primitive ranges may, however, still be essentially retained by the races of *amabilis* and of *punctatus*, although in the latter group *docilis* may be much older than its four derivatives.

LITERATURE CITED IN TEXT

Abbott, Charles C.
1868 Catalogue of vertebrate animals of New Jersey. Geol. New Jersey, Appendix E, p. 751-830.

Atkinson, D. A.
1901 The reptiles of Allegheny County, Pennsylvania. Ann. Carnegie Mus., vol. 1, p. 145-157.

Atsatt, Sara R.
1913 The reptiles of the San Jacinto area of southern California. Univ. Calif. Publ. Zool., vol. 12, no. 3, p. 31-50.

Baird, Spencer F.
1859 Reptiles of the boundary. Rep. U. S. Mex. Bound. Surv., vol. 2, p. 1-35, pl. 1-41.

Baird, Spencer F. and Charles Girard
1853 Catalogue of North American reptiles in the museum of the Smithsonian Institution. Part I. Serpents. Washington: Smithsonian Inst., xvi, 172 p.

Barbour, Thomas
1919 Herpetological notes: Regarding *Diadophis punctatus*. Proc. New England Zool. Club, vol. 7, p. 7-10.

Bicknell, E. P.
1882 A review of the summer birds of a part of the Catskill Mountains. Trans. Linn. Soc. New York, vol. 1, p. 115-168.

Bishop, Sherman C.
1923 Notes on the herpetology of Albany County, New York. III. Copeia, no. 125, p. 117-120.

1927 The amphibians and reptiles of Allegany State Park. New York St. Mus. Handbook no. 3, 141 p., 58 fig. 1 map.

Blanchard, Frank N.
1921 A revision of the king snakes: genus *Lampropeltis*. Bull. U. S. Nat. Mus., no. 114, vi, 260 p., 75 fig.
1923 Comments on ring-neck snakes (genus *Diadophis)*, with diagnoses of new forms. Occ. Papers Univ. Mich. Mus. Zool., no. 142, 9 p.
1925 A key to the snakes of the United States, Canada and Lower California. Papers, Mich. Acad. Sci. Arts, Let., vol. 4 (1924), pt. 2, xiii, 65 p., 78 fig.
1927 Eggs and young of the eastern ring-neck snake, *Diadophis punctatus edwardsii*. Papers, Mich. Acad. Sci. Arts, Let., vol. 7 (1926) , p. 279-292, pl. 13-19.
1930 Further studies of the eggs and young of the eastern ring-neck snake, *Diadophis punctatus edwardsii*. Bull. Antivenin Inst. Amer., vol. 4, no. 1, p. 4-10, fig. 1-7.
1931 Secondary sex characters of certain snakes. Bull. Antivenin Inst. Amer., vol. 4, no. 4, p. 95-104, fig. 1-11.
1937 Eggs and natural nests of the eastern ring-neck snake, *Diadophis punctatus edwardsii*. Papers, Mich. Acad. Sci. Arts, Let., vol. 22 (1936), p. 521-532, pl. 53-57, fig. 12-14.

Bogert, Charles M.
1930 An annotated list of the amphibians and reptiles of Los Angeles County, California. Bull. So. Calif. Acad. Sci., vol. 29, pt. 1, p. 3-14, 1 map.

Boettger, 0.
1898 Katalog der Reptilien-Sammlung im Museum der Senckenbergischen Naturforschenden Gesellschaft in Frankfurt am Main. Teil 2. Schlangen. Frankfurt a. M.: 160 p.

Branson, Edwin B.
1904 The snakes of Kansas. Univ. Kans. Sci. Bull., vol. 2, no. 13, p. 353-430, 39 fig.

Breckenridge, W. J.
1942 Ring-necked snakes in Minnesota. Copeia, no. 2, p. 128.

Breder, C. M. and Ruth B. Breder
1923 A list of fishes, amphibians and reptiles collected in Ashe County, North Carolina. Zoologica, vol. 4, no. 1, p. 3-23.

Brennan, L. A.
1934 A check list of the amphibians and reptiles of Ellis County, Kansas. Trans. Kans. Acad. Sci., vol. 37, p. 189-191.

Breukelman, John and Allen Downs
1937 A list of amphibia and reptiles of Chase and Lyon Counties, Kansas. Trans. Kans. Acad. Sci., vol. 39 (1936), p. 267-268.

Brimley, C. S.
1909 Some notes on the zoology of Lake Ellis, Craven County, North Carolina, with special reference to herpetology. Proc. Biol. Soc. Washington, vol. 22, p. 129-137.
1910 Records of some reptiles and batrachians from the southeastern United States. Proc. Biol. Soc. Washington, vol. 23, p. 9-18.

Britcher, Horace W.
1903 Batrachia and Reptilia of Onondaga County [New York]. Proc. Onondaga Acad. Sci., vol. 1, p. 120-122.

Brown, J. Roland
1928 The herpetology of Hamilton, Ontario, and district. Canad. Field Nat., vol. 42, p. 125-127.

Burt, Charles E.
1927 An annotated list of the amphibians and reptiles of Riley County, Kansas. Occ. Papers Univ. Mich. Mus. Zool., no. 189, 9 p.

Cagle, Fred R.
1942 Herpetological fauna of Jackson and Union Counties, Illinois. Amer. Midl. Nat., vol. 28, no. 1, p. 164-200, fig. 1-15.

Cahn, Alvin R.
1929 The herpetology of Waukesha County, Wisconsin. Copeia, no. 170, p. 4-8.

Campbell, Berry
1934 Report on a collection of reptiles and amphibians made in Arizona during the summer of 1933. Occ. Papers Univ. Mich. Mus. Zool., no. 289, 10 p.

Carr, A. F., Jr.
1940 A contribution to the herpetology of Florida. Univ. Fla. Publ., Biol. Sci. Ser., vol. 3, no. 1, 118 p.

Clark, Hubert L.
1904 Notes on the reptiles and batrachians of Eaton County. Fourth Ann. Rep. Mich. Acad. Sci., p. 192-194.

Conant, Roger
1938 The reptiles of Ohio. Amer. Midl. Nat., vol. 20, no. 1, p. 1-200, 38 maps, 26 pl.
1942 Amphibians and reptiles from Dutch Mountain (Pennsylvania) and vicinity. Amer. Midl. Nat., vol. 27, no. 1, p. 154-170.

Cope, E. D.
1880 On the zoological position of Texas. Bull. U. S. Nat. Mus., no. 17, 51 p.
1883 Notes on the geographical distribution of Batrachia and Reptilia in western North America. Proc. Acad. Nat. Sci. Philadelphia, vol. 35, p. 10-35.
1887 Catalogue of Batrachia and Reptilia of Central America and Mexico. Bull. U. S. Nat. Mus., no. 32, 98 p.
1894 The classification of snakes. Amer. Nat., vol. 28, p. 831-844, pl. 27, 28.
1900 The crocodilians, lizards and snakes of North America. Ann. Rep. U. S. Nat. Mus. (1898), p. 153-1270, 347 fig., 36 pl.

Corrington, J. D.
1927 Field notes on some amphibians and reptiles at Biloxi, Mississippi. Copeia, no. 165, p. 98-102.
1929 Herpetology of the Columbia, South Carolina, region. Copeia, no. 172, p. 58-83.

Cragin, F. W.
1881 A preliminary catalogue of Kansas reptiles and batrachians. Trans. Kans. Acad. Sci., vol. 7, p. 114-123.

Deckert, Richard F.
1918 A list of reptiles from Jacksonville, Florida. Copeia, no. 54, p. 30-33.

De Kay, James E.
1842 Zoology of New York. III. Reptiles and Amphibia. Albany: vii, 98 p., 23 pl.

Dice, Lee R.
1923 Notes on the communities of the vertebrates of Riley County, Kansas, with special reference to amphibians, reptiles and mammals. Ecology, vol. 4, no. 1, p. 40-53.

Ditmars, R. L.
1896 The snakes found within fifty miles of New York City. Abst. Proc. Linn. Soc. N. Y., no. 8, p. 9-24.
1907 The reptile book. New York: Doubleday, Page and Co., xxxii, 472 p., 136 pl.

Dory, Ralph
1932 Notes on reptiles and amphibians from Clifty Falls State Park, Jefferson County, Indiana. Proc. Jun. Soc. Nat. Sci. Cincinnati, vol. 3, no. 2, p. 23-26.
1932 Recent acquisitions to the department of herpetology. Proc. Jun. Soc. Nat. Sci. Cincinnati, vol. 3, no. 2, p. 26-28.

Dury, Ralph and William Gessing, Jr.
1940 Additions to the herpetofauna of Kentucky. Herpetologica, vol. 2, no. 2, p. 31-32.

Eckel, Edwin C. and Frederick C. Paulrnier
1902 Catalogue of New York reptiles and batrachians. Bull. N. Y. St. Mus., no. 51, p. 355-414.

Ellis, Max M. and Junius Henderson
1913 The Amphibia and Reptilia of Colorado, Part I. Univ. Colo. Studies, vol. 10, no. 2, p. 39-129, 8 pl., 3 fig.

Englehardt, G. P., J. T. Nichols, Roy Latham, and R. C. Murphy
1915 Long Island snakes. Copeia, no. 17, [p. 1-4].

Fitch, Henry S.
1936 Amphibians and reptiles of the Rogue River Basin, Oregon. Amer. Midl. Nat., vol. 17, no. 3, p. 634-652.

Force, Edith R.
1930 The amphibians and reptiles of Tulsa County, Oklahoma, and vicinity. Copeia, no. 2, p. 25-39.

Fowler, Henry W.
1907 The amphibians and reptiles of New Jersey. Ann. Rep. N. J. St. Mus. (1906), p. 23-250, 69 pl.
1925 Records of amphibians and reptiles for Delaware, Maryland, and Virginia. II. Copeia, no. 145, p. 61-64.

Funkhouser, W. D.
1925 Wild life in Kentucky. Ky. Geol. Surv., ser. 6, vol. 16, 385 p., 89 fig.

Garman, H.
1892 A synopsis of the reptiles and amphibians of Illinois. Bull. Ill. St. Lab. Nat. Hist., vol. 3, art. 13, p. 215-389, pl. 9-15.

Gloyd, Howard K.
1928 The amphibians and reptiles of Franklin County, Kansas. Trans. Kans. Acad. Sci., vol. 31, p. 115-141.

1932 The herpetological fauna of the Pigeon Lake region, Miami County, Kansas. Papers, Mich. Acad. Sci., Arts, Let., vol. 15 (1931), p. 389-409, pl. 30-32.

Graf, William, Stanley G. Jewett, Jr., and Kenneth L. Gordon
1939 Records of amphibians and reptiles from Oregon. Copeia, no. 2, p. 101-104.

Gray, I. E.
1941 Amphibians and reptiles of the Duke Forest and vicinity. Amer. Midl. Nat., vol. 25, no. 3, p. 652-658.

Green, N. Bayard
1937 The amphibians and reptiles of Randolph County, West Virginia. Herpetologica, vol. 1, no. 4, p. 113-116.

Grinnell, Joseph
1908 The biota of the San Bernardino Mountains. Univ. Calif. Publ. Zool., vol. 5, no. 1, p. 1-170, 24 pl.

Grinnell, Joseph and Hilda Wood Grinnell
1907 Reptiles of Los Angeles County, California. Throop Inst. Bull., no. 35, Sci. Ser., no. 1, 64 p., 23 fig.

Günther, Albert
1858 Catalogue of the colubrine snakes in the collection of the British Museum. London: xvi, 281 p.

Guthrie, J. E.
1926 The snakes of Iowa. Bull. Iowa St. Agric. Exp. Sta., no. 239, p. 147-192, 21 fig., 5 pl.

Hahn, Walter L.
1908 Notes on the mammals and cold-blooded vertebrates of the Indiana University Farm, Mitchell, Indiana. Proc. U. S. Nat. Mus., vol. 35, p. 545-581.

Hay, Oliver Perry
1892 The batrachians and reptiles of the state of Indiana. Ann. Rep. Dept. Geol. Nat. Res. Ind., no. 17 (1891) , p. 409-602, 3 pl.

Heerman, A. L.
1859 List of reptiles collected [Williamson's route]. Rep. Expl. Surv. Pacific Railroad, vol. 10, pt. 4, p. 24 [supplement to Hallowell's report on the reptiles].

Hibbard, Claud W.
1937 *Hypsiglena ochrorhynchus* in Kansas and additional notes on *Leptotyphlops dulcis.* Copeia, no. 1, p. 74.

Hough, Franklin B.
1852 Catalogue of reptiles and fishes from St. Lawrence County, procured for the State Cabinet of Natural History. Fifth Ann. Rep. N. Y. St. Cab. Nat. Hist., p. 23-28.

Hubbell, T. H.
1936 A monographic revision of the genus *Ceuthophilus* (Orthoptera, Gryllacrididæ, Rhaphidophorinæ). Univ. Fla. Publ., vol. 2, no. 1, 551 p., 38 pl.

Hughes, Edward
1886 Preliminary list of reptiles and batrachians of Franklin County [Indiana]. Bull. Brookville Soc. Nat. Hist., no. 2, p. 40-45.

Hurter, Julius
1911 Herpetology of Missouri. Trans. Acad. Sci. St. Louis, vol. 20, no. 5, p. 59-274, pl. 18-24.
1912 Reptiles and amphibians of Laguna Beach. First Ann. Rep. Laguna Marine Lab., p. 67.

Hurter, Julius and John K. Strecker
1909 The amphibians and reptiles of Arkansas. Trans. Acad. Sci. St. Louis, vol. 18, no. 2, p. 11-27.

Jones, J. M.
1865 Contributions to the natural history of Nova Scotia. Reptilia. Nova Scotian Inst. Sci., p. 1-15.

Jopson, Harry G. M.
1940 Reptiles and amphibians from Georgetown County, South Carolina. Herpetologica, vol. 2, no. 2, p. 39-43.

Kennicott, Robert
1859 Notes on *Coluber calligaster* Say, and a description of new species of serpents in the collection of the North Western University of Evanston, Illinois. Proc. Acad. Nat. Sci. Philadelphia, p. 98-100.

King, Willis
1939 A survey of the herpetology of Great Smoky Mountains National Park. Amer. Midl. Nat., vol. 21, no. 3, p. 531-582, 9 fig.

Klauber, Laurence M.
1924 Notes on the distribution of snakes in San Diego County, California. Bull. Zool. Soc. San Diego, no. 1, 22 p., 5 fig.
1928 A list of the amphibians and reptiles of San Diego County, California. Bull. Zool. Soc. San Diego, no. 4, 8 p. 2nd ed., 1930,
1931 A statistical survey of the snakes of the southern border of California. Bull. Zool. Soc. San Diego, no. 8, 93 p., 8 fig.

Langlois, T. H.
1925 Notes on some Michigan snakes. Papers, Mich. Acad. Sci. Arts, Let., vol. 4 (1924), p. 605-610.

Latham, Roy
1915 Ring-neck snake at Orient, Long Island. Copeia, no. 25, p. 61.

Linsdale, Jean M.
1927 Amphibians and reptiles of Doniphan County, Kansas. Copeia, no. 164, p. 75-81.

Linsley, James H.
1844 A catalogue of the reptiles of Connecticut, arranged according to their natural families; prepared for the Yale Natural History Society. Amer. Journ. Sci. Arts, vol. 46 (1843), no. 1, p. 37-51.

Löding, H. P.
1922 A preliminary catalogue of Alabama amphibians and reptiles. Geol. Surv. Ala., Mus. Paper no. 5, p. 7-59.

Lönnberg, Einar
1894 Notes on reptiles and batrachians collected in Florida in 1892 and 1893. Proc. U. S. Nat. Mus., vol. 17, p. 317-339, 3 fig.

McCauley, Robert H., Jr.
1941 *Diadophis punctatus* in Maryland. Copeia, no. 1, p. 55.

McCauley, Robert H., Jr. and Charles S. East
1940 Amphibians and reptiles from Garrett County, Maryland. Copeia, no. 2, p. 120-123.

Mac Kay, A. H.
1896 [Informal discussion of a *Diadophis punctatus* from "Pine Hill, near the Park"—probably Halifax; of a *Eutainia sirtalis* chasing a frog; of a *Diemyctylus viridescens;* and a list of batrachians and reptiles inhabiting Nova Scotia.] Proc. Nova Scotian Inst. Sci., vol. 9, pt. 2, p. xli-xliii.

Mattern, E. S. and W. I. Mattern
1917 Amphibians and reptiles of Lehigh County, Pennsylvania. Copeia, no. 46, p. 64-66.

Meade, George P.
1940 Observations on Louisiana captive snakes. Copeia, no.. 3, p. 165-168.

Morse, Max
1901 Ohio reptiles in the Ohio State University Zoological Museum. Ohio Nat., vol. 1, p. 126-128.
1904 Batrachians and reptiles of Ohio. Proc. Ohio St. Acad. Sci., vol. 4, pt. 3, Spec. Paper no. 9, p. 91-144, 1 pl.

Myers, George S.
1930 Amphibians and reptiles observed in the Palisades Interstate Park, New York and New Jersey. Copeia, no. 173, p. 99-103.

Neill, Wilfred T., Jr.
1941 A case of albinism in *Diadophis p. punctatus.* Copeia, no. 4, p. 266.

Ortenburge r, A. I.
1926 A preliminary list of the snakes of Oklahoma. Proc, Okla. Acad. Sci., vol. 5, no. 11, p. 83-87.

Ortenburger, A. I. and Beryl Freeman
1930 Notes on some reptiles and amphibians from western Oklahoma. Publ. Univ. Okla. Biol. Surv., vol. 2, no. 4, p. 175-188.

Over, William H.
1923 Amphibians and reptiles of South Dakota. S. Dak. Geol. Nat. Hist. Surv., Bull. 12, ser. 23, no. 10, 34 p., 18 pl.

Parker, Malcolm V.
1937 Some amphibians and reptiles from Reelfoot Lake. Journ. Tenn. Acad. Sci., vol. 12, no. 1, p. 60-86, 6 fig.
1939 The amphibians and reptiles of Reelfoot Lake and vicinity, with a key for the separation of species and subspecies. Journ. Tenn. Acad. Sci., vol. 14, no. 1, p. 72-101, 14 fig.

Pawling, R. Oldt
1939 The amphibians and reptiles of Union County, Pennsylvania. Herpetologica, vol. 1, no. 6, p. 165-169.

Piatt, Jean
1931 Herpetological report of Morgan County, Indiana. Proc. Ind. Acad. Sci., vol. 40 (1930), p. 361-368.

Pickens, A. L.
1927 Reptiles of upper South Carolina. Copeia, no. 165, p. 110-113.

Piers, Harry
1895 Notes on Nova Scotian zoology, no. 2. Trans. Nova Scotian Inst. Sci., vol. 8, p. 175-184.

Pope, T. E. B. and W. E. Dickinson
1928 The amphibians and reptiles of Wisconsin. Bull. Milwaukee Publ. Mus., vol. 8, no. 1, 138 p., 21 pl., 28 text fig.

Reed, H. D. and A. H. Wright
1909 The vertebrates of the Cayuga Lake Basin, N. Y. Proc. Amer. Philos. Soc., vol. 48, p. 370-459.

Ricketson, Oliver G.
1911 A list of Reptilia collected at Concord, Mass. Proc. Thoreau Mus. Nat. Hist., vol. 1, p. 11-13.

Ridgway, Robert
1912 Color standards and color nomenclature. Publ. by author, Washington: iv, 44 p., 53 pl.

Ruthven, A. G.
1908 Variations and genetic relationships of the garter snakes. Bull. U. S. Nat. Mus., no. 61, xii, 201 p., 82 fig., 1 p1.

Ruthven, A. G., Crystal Thompson, and Helen Thompson Gaige
1928 The herpetology of Michigan. Mich. Handbook Ser., no. 3, Univ. Mich., ix, 229 p., 52 fig., 20 p1.

Schmidt, Karl P.
1924 A list of amphibians and reptiles collected near Charleston, S. C. Copeia, no. 132, p. 67-69.

Smith, Hobart M. and A. B. Leonard
1934 Distributional records of reptiles and amphibians in Oklahoma. Amer. Midl. Nat., vol. 15, no. 2, p. 190-196.

Stejneger, Leonhard
1940 `Sonora" as the locality of the Graham-Clark reptile collections of 1851. Copeia, no. 3, p. 204-205.

Stephens, Frank
1921 An annotated list of the amphibians and reptiles of San Diego County, California. Trans. San Diego Soc. Nat. Hist., vol. 3, no. 4, p. 57-69.

Stone, Witmer
1903 A collection of reptiles and batrachians from Arkansas, Indian Territory, and western Texas. Proc. Acad. Nat. Sci. Philadelphia, p. 538-542.
1911 On some collections of reptiles and batrachians from the western United States. Proc. Acad. Nat. Sci. Philadelphia, p. 222-232.

Strecker, John K.
1908 The reptiles and batrachians of McLennan County, Texas. Proc. Biol. Soc. Washington, vol. 21, p. 69-84
1924 Notes on the herpetology of Hot Springs, Arkansas. Baylor Bull., vol. 27, no. 3, pt. 3, p. 29-47.

Strecker, John K. and Walter J. Williams
1928 Field notes on the herpetology of Bowie County, Texas. Contrib. Baylor Univ. Mus., no. 17, 19 p.

Surface, H. A.
1906 The serpents of Pennsylvania. Penn. St. Dept. Agric. Month. Bull., Div. Zool., vol. 4, no. 4 and 5, p. 113-202, fig. 4-23, pl. 14-42.

Svihla, Arthur
1938 Occurrence of the ring-necked snake in the state of Washington. Copeia, no. 1, p. 47.

Swanson, Paul L.
1939 Herpetological notes from Indiana. Amer. Midl. Nat., vol. 22, no. 3, p. 684-695, pl. 1-3.

Tanner, Wilmer W.
1940 Herpetological specimens added to the Brigham Young University collection. Great Basin Nat., vol. 1, no. 3 and 4, p. 138-146.
1941 A study of the variation in the less common snakes of Utah. Great Basin Nat., vol. 2, no. 1, p. 16-28.

Taylor, Edward H.
1929 A revised check list of the snakes of Kansas. Univ. Kans. Sci. Bull., vol. 19, no. 5, p. 53-62.
1940 Some Mexican serpents. Univ. Kans. Sri. Bull., vol. 26, no. 14, p. 445-487, 9 fig., pl. 49-52.

Taylor, Edward H. and Hobart M. Smith
1939 Miscellaneous notes on Mexican. snakes. Univ. Kans. Sci. Bull., vol. 25, no. 13, p. 239-258, 4 fig., pl. 23.

Taylor, W. Edgar
1892 Ophidia of Nebraska. Ann. Rep. Nebr. St. Bd. Agric. (1891), p. 310-357, map.

Trapido, Harold
1937 A guide to the snakes of New Jersey. Newark Mus., 60 p., 52 fig.

Trowbridge, Albert H.
1937 Ecological observations on amphibians and reptiles collected in southeastern Oklahoma during the summer of 1934. Amer. Midl. Nat., vol. 18, no. 2, p. 285-302, 1 fig.

Uhler, F. M.
1940 The western ring-necked snake in Idaho. Copeia, no. 2, p. 136.

Van Denburgh, John
1897 The reptiles of the Pacific Coast and Great Basin. Occ. Papers Calif. Acad. Sci., no. 5, 236 p., 67 fig.
1922 The reptiles of western North America. Occ. Papers Calif. Acad. Sci., no. 10, vol. 2, Snakes and Turtles, p. 617-1028, pl. 58-128.

Van Denburgh, John and Joseph R. Slevin
1913 A list of amphibians and reptiles of Arizona with notes on the species in the collection of the Academy. Proc. Calif. Acad. Sci., ser. 4, vol. 3, p. 391-454, pl. 17-28.
1923 Preliminary diagnoses of four new snakes from Lower California, Mexico. Proc. Calif. Acad. Sci., ser. 4, vol. 13, p. 1-2.

Van Wagenen, G.
1917 *Diadophis amabilis* in Missouri. Copeia, no. 43, p. 43-44.

von Bloeker, Jack C., Jr.
1942 Amphibians and reptiles of the dunes [El Segundo, Los Angeles Co., Calif.]. Bull. So. Calif. Acad. Sci., vol. 41, pt. 1, p. 29-38.

Welter, Wilfred A. and Katherine Carr
1939 Amphibians and reptiles of northeastern Kentucky. Copeia, no. 3, p. 128-130.

Wright, A. H. and S. C. Bishop
1915 A biological reconnaissance of the Okefinokee Swamp in Georgia. The Reptiles. Pt. 2, Snakes. Proc. Acad. Nat. Sci. Philadelphia, p. 107-192, 3 pl., 14 fig.

Woodbury, Angus M.
1928 The reptiles of Zion National Park. Copeia, no. 166, p. 14-21.

Yarrow, H. C.
1882 Check list of North American Reptilia and Batrachia, with catalogue of specimens in U. S. National Museum. Bull. U. S. Nat. Mus., no. 24, 249 p.

ERRATA

p. 29, paragraph 2, line 1, for "subject" read subject.
p. 33, line 14, for "accurs" read occurs.
p. 39, paragraph 4, line 8, for "Berkley" read Berkeley.
p. 57, paragraph 3, line 3, read Van Denburgh and Slevin (1913).
p. 59, line 7, read Yarrow (1882) .
p. 75, under HABITAT, line 2, read Taylor (1892, p. 346) .
" " line 17, read Ortenburger and Freeman (1930).
p. 77, second line from bottom, read (1927, p. 283) .
p. 81, under NEBRASKA, read Dury (1932, p. 28).
p. 93, line 14, read *Coronella*.
p. 103, line 13, read Inst. Sci., vol. 9 (1895-6), 1896, p. xli, xliii.
line 15, read vol. 8, 1895, p. 181.

INDEX